ROUGHING-IN
House Drains

A Complete Guide, From The Digging of The Sewer To The Finishing Length of The House Drain, Giving Each Step To Be Taken and Telling How and Why It Is Done

Edited By

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CONSTRUCTING THE HOUSE SEWER.

Protecting Cellar and Foundation Walls.

WHEN work is first started on a building that is to be erected, it is common practice to connect the cellar excavation with the sewer and run the water pipe from the water main to the building line so that a plentiful supply of water will be obtainable for building purposes, and the building site will be properly drained. Installing the water supply pipe is more in the nature of a convenience than a necessity, but extending the sewer to the cellar line is both a necessity and a convenience. On large buildings, the sewer not only maintains a dry site, and keeps the cellar from being flooded with consequent damage to the foundation walls, but it also permits the installation of temporary water closets for the convenience of workmen. So necessary are these requirements in building operations that the laws of many cities require the house sewer to be installed as soon as the foundations are started and require the rain leaders to be connected to the house drain as soon as the roof is completed. Owing to these requirements of building laws and to the like requirements of care-

ful superintendents and architects who are particular as to details, the practice is fast gaining ground of installing the water supply pipe and the house sewer as soon as work is commenced excavating the cellar; and, as at that early stage of proceedings, the plumbing contract seldom is let, the practice is becoming generally adopted of letting this portion of the plumbing work under a separate contract.

TEMPORARY DRAINAGE AND SEWAGE DISPOSAL.

When the street sewer into which the house sewer discharges is at such a level that all sewage and drainage can discharge into it by gravity, the toilet accommodations for the workmen are usually located in the cellar. When, however, the street sewer is so near the surface of the street that the cellar bottom extends below the springing line of the arch in the sewer, the toilet accommodations are located either in a special building outside of the building to be erected, or they are all located on the first floor of the building and discharge by gravity into the sewer, while the drainage water is collected in a sump from which it is discharged into the sewer by a compressed air injector, or by pumps, which may be operated either by hand or by power.

UTILIZATION OF OLD SEWERS.

When erecting a new building on the site of an old building the question often arises as to whether

the old house sewer and water service pipe can be used for the new building. This matter can best be determined by examination. If the sewer is in good condition, the joints tight, the hubs uncracked, the sewer in good alignment, and laid at a good grade, no objection could reasonably be interposed against the use of the sewer provided it was not choked by roots of trees, or obstructed in any other manner. Before using an old sewer it is good practice to clean it out thoroughly and make sure there are no projecting points of cement to catch matter passing through the sewer. The condition of the interior of a house sewer generally can be seen by a person looking through the house end of the sewer while an assistant holds a lighted lantern, candle or lamp at the outlet end where it discharges into the main sewer.

OBTAINING PERMITS.

Should a new house sewer be deemed necessary instead of the old one, or when building on a plot where there is no old house sewer, one of the first requirements is to obtain a permit to open the street and another to connect with the sewer. Permits are issued only to licensed plumbers or contractors who have complied with the requirements of the Building, Health, Highway and Sewer Departments and have filed a bond indemnifying the city for any damage arising from their acts. Some cities require that

where a street is to be opened within a certain distance from a park or parkway, that a permit be obtained from the park commissioners also. When provided with the necessary permits (which are usually placed in the keeping of the one in charge of the excavation) the actual work of constructing the house sewer begins.

PRELIMINARY SEWER WORK.

The depth of the sewer in the street can be ascertained by measuring at the nearest manhole and if the main sewer be of pipe, the location of the branch connection, for the building site on which the building is to be erected, can be ascertained from the Department of Sewers, which keeps a record of the exact location of each branch connection.

When the trench from a sewer must cross a lawn, as for instance when running a sewer to an occupied building, judgment should be exercised so to locate the trench that trees or shrubbery will not have to be removed or destroyed, and that unnecessary inconvenience will not be imposed on the inmates. The sod should be carefully removed and laid at one side so it can be replaced when the trench is filled, and the top soil should be piled in a heap where it will be accessible when wanted. If there is danger of the earth thrown from the trench banking against the fence, walls, buildings or other works which the earth would soil or stain, boards, tar-

paulin or some other protecting material should be used to prevent injury.

DIGGING THE TRENCH.

In digging the trench care should be exercised not to go too deep, for, if a pipe trench is extended below the required level, earth will have to be filled in before the sewer is laid, and the foundation thus provided at some future time is likely to settle and cause a leak in the sewer.

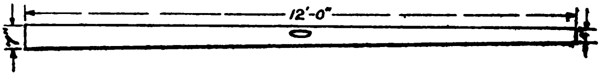


Fig. 1.

It is good practice to dig the pipe trench at a uniform grade from the street sewer to the foundation line and in a perfectly straight line so the house sewer when laid will have a true alignment, and a uniform grade throughout its entire length. In order to insure a uniform grade for the trench bottom it is well to provide the laborers with a spirit lever and a leveling board similar to Fig. 1 with which to obtain the proper grade. A leveling board is made of pine or other soft wood that is not easily warped or twisted out of shape, and is laid out by making the board as much wider at one end as there will be fall in that length of the house sewer. For instance, if the house sewer is to have a fall of one-

quarter inch per foot, and the leveling board is twelve feet long and 4 inches wide at the narrow end, then the wide end would be $12 \times \frac{1}{4} + 4 = 7$ inches wide. Having a board of this description, when the edge is laid on the bottom of the trench with the wide end toward the street sewer, and the top edge of the board is level, the trench has the proper grade. When a trench is excavated to the proper depth and the bottom is graded to a uniform fall, by scooping the earth away from the points where the hubs will be located, as shown in Fig. 2, the pipes will have a bearing along their extra lengths.

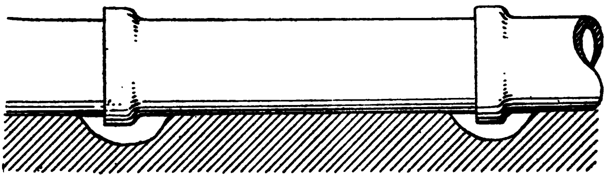


Fig. 2.

EXCAVATING.

When excavating a trench in which to lay a house sewer pipe, the work can be more economically performed when the trench is made of sufficient width for the workmen to move about with ease than when the trench is made narrow and converging toward a point near the bottom. The width of a trench should be proportioned to the depth it must be car-

ried and the material through which the trench must be dug. For a trench of moderate depth through loam, dry clay, hard pan or coarse compact gravel and clay, a trench eighteen or twenty inches wide under ordinary conditions will be sufficient, whereas, if carried to a depth of 10 or 12 feet it would be greater economy to make the trench about 3 feet at the top and give the walls a slight batter toward the bottom of the trench.

EXCAVATING THROUGH ROCK.

When a plumber is called upon to construct a sewer through a stretch of land that is underlaid with a hard rock which requires blasting to remove, the better way, and the way generally followed, is to secure estimates from a quarryman or excavator who is skilled in that class of work and who, besides assuming all responsibility for damage arising from the operation of blasting, will be able to excavate the trench at considerable less cost than would the plumbing contractor.

Excavating a trench through rock is not such a simple matter as might at first appear. Besides the danger incident to handling explosives, there is the additional danger to nearby property or to passersby when a blast is not properly protected by logs, matting and brambles, or when too large a charge is used for the purpose. Another danger more real than apparent is the liability to cause a rupture of

gas or water pipes, which, being concealed from view in the earth, are forgotten when drilling for a charge of explosive, and on more than one occasion have been ruptured, causing considerable loss, all of which must be borne by the contractor.

EXCAVATING IN WET LAND.

Excavating wet trenches is another undertaking which requires skill and judgment to properly and

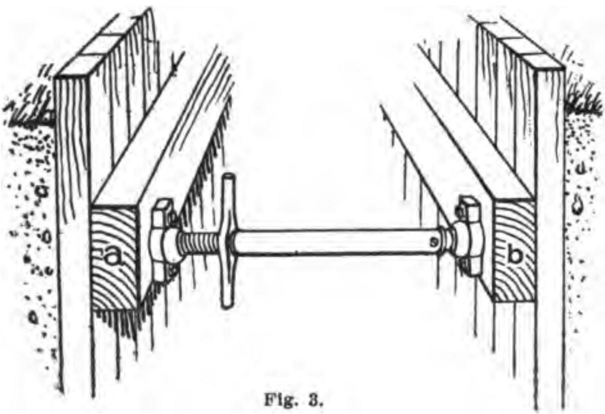


Fig. 3.

economically perform. Trenches that are to be carried to a depth of 10 or 12 feet, through wet clay, quicksand or marshy soil of any kind which is likely to cave, should be made at least 4 feet wide at the top to allow for sheet piling and staging.

A method of sheet piling a trench to prevent caving of the banks is shown in section in Fig. 3. In this method the trench is started and carried to what is considered a safe depth without the use of sheet piling. When a depth is reached, however, that borders on the danger limit, four planks with pointed ends, two on each side of the trench and about 12 feet apart, are driven into the soft earth as far as they will easily go. Two timbers *a b* are then placed in the trench, on each side tight against the sheet piling, and cross braces *c* which may be either of wood wedged tightly in place or iron adjustable braces, as shown in the illustration, hold the horizontal timbers in position to support the upper part of the planks which are driven on both sides of the trench between the timber *a* and *b* respectively and the banks they support. When the trench is carried to such a depth that the workmen cannot throw the dirt out of the trench, a platform can be built at a convenient distance from the top of the trench and the earth removed in relays. Care should be exercised by the workmen in charge of a sewer excavation in wet or treacherous soil to have all earth from the trench shoveled back a sufficient distance so the weight will not cause the banks to cave.

KEEPING TRENCH FREE FROM WATER.

In order that the workmen may make headway both in excavating the sewer trench and in laying

the sewer pipe, it is necessary to keep the trench free from water until the cement in the joints of the

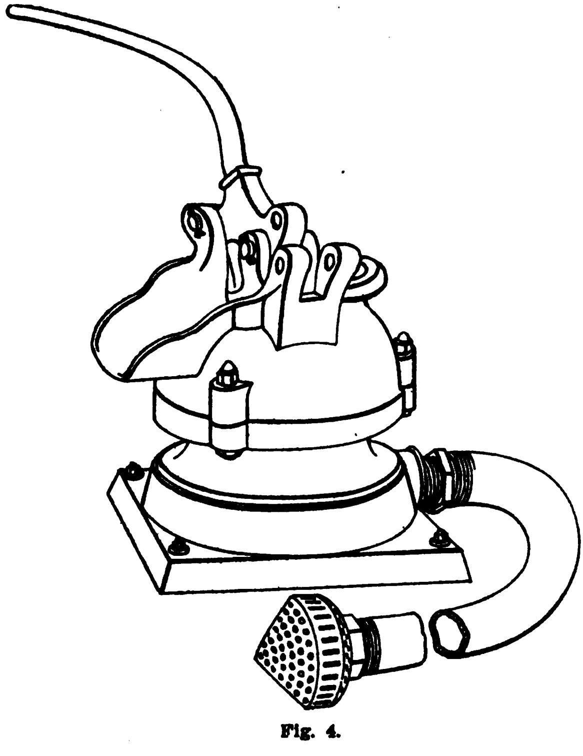


Fig. 4.

tile pipe has had time for the initial "set." Sometimes drainage can be provided by digging down to the main street sewer and puncturing a hole through

the wall where the house sewer will connect into it, then letting the ground water flow into the street sewer through this hole which should be well protected by a wire screen. Where natural drainage cannot be had, a pump similar to the one shown in Fig. 4 will be found quite suitable for small trenches, while for large excavations where the amount of water to be handled is excessive a power pump will be found more satisfactory. The pump shown in the illustration has a capacity of 3,500 gallons per hour and can be operated by one man at a time; a flexible rubber suction hose with a suction strainer makes easy the shifting of this type of pump from point to point in the trench.

SEWER CONNECTIONS.

When the sewer trench is ready, the first thing to do is to make the house sewer connection to the street sewer. The method of connecting to the street sewer depends to a great extent upon the type of sewer in the street. If the main sewer be made of brick, the connection should be made just above the springing line of the arch, as shown in Fig. 5. A neat hole should be cut for the admission of the branch pipe and the chips of bricks should be prevented from falling into the sewer. This point should be emphasized in view of the fact that many workmen make a breach in the wall of a sewer by driving in two or three bricks and letting the bricks

lay in the sewer where they fall. When the sewer pipe is permanently set in place, the wall of the sewer, both inside and outside, where possible, should be neatly pointed with cement mortar to close the joint around the pipe. When the street sewer is too small for a man to work inside of it, the pointing, of course, must be omitted. When fitting the house sewer branch into the street sewer it should project far enough so the sewage will fall clear of the walls. It is good practice also to use a long sweeping ⅛ bend to connect with the sewer and point the bend in the direction of the outlet of the sewer. By this means the inflowing sewage will not check the flow in the main sewer. It might be added that it is not so necessary to use a bend in a sewer of large diameter and ordinarily a straight length of pipe is used.

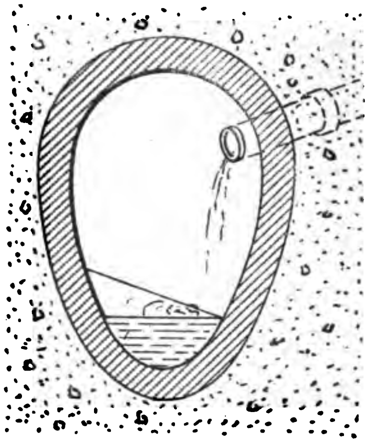


Fig. 5.

CONNECTIONS TO PIPE SEWERS.

Connections to pipe sewers are made in an entirely different manner from connections to brick sewers. In many cities Y and double Y branch fittings are laid in the main street sewer every 25 feet or thereabouts, when the sewer is being built. When such a system is followed two branches are provided at stated intervals, one branch facing each side of the street. When such is the case, all that is necessary, when excavating for the sewer trench, is to find the location of the most convenient branch. This information can be obtained from

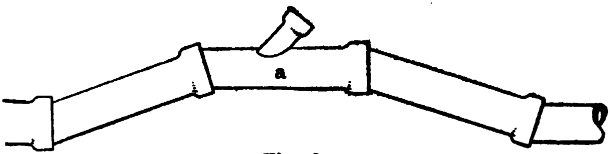


Fig. 6.

the commissioner of sewers or at the office of the Department of Sewers, where a record is kept showing the exact location of each branch fitting.

When branches are not provided in the main sewer during construction, it becomes necessary when making a connection to remove a length of pipe from the sewer and substitute in its place a branch fitting. There are three methods commonly followed for tapping a sewer. The first method is shown in Fig. 6. A section consisting of three or

four lengths of pipe is removed from the main sewer and a corresponding section with a branch fitting *a* is sprung back into place, the branch turned in the right direction, the joints cemented and the branch is ready to be connected to. This method of inserting a branch fitting in a pipe sewer main is open to no objection from a structural standpoint. Indeed when the work is carefully performed, and the joints well made, the sewer is in as good condition after the fitting is inserted as it

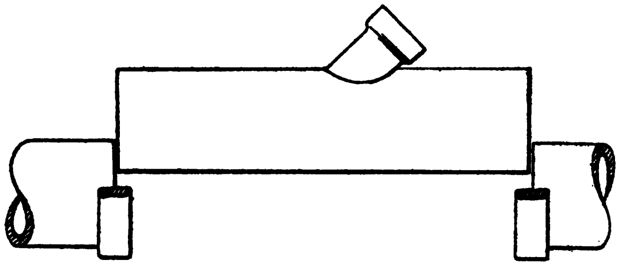


Fig. 7.

was originally. Owing, however, to the length of trench that must be dug along the sewer main in order to make accessible the section to be removed, one of the two methods about to be described is generally resorted to.

Some sewer mains are made of hubless pipes, which have their ends joined, as shown in Fig. 7, by means of split rings of stoneware which are bedded in cement and have a layer of cement mortar

interposed between them and the sewer pipe. When street sewers are constructed of this type of pipe, the top half of the ring covering the two joints of the length of pipe to be removed are broken away, the length of pipe is then loosened and removed, or, if wedged in too tight to be removed whole the pipe is broken and the fragments carefully removed from the sewer. The old cement is then carefully removed from the bottom half of the rings, replacing the rings with new ones should they become broken during the operation, and, after spreading the lower half of the rings with cement mortar, the branch pipe is lowered into place, the joint covered with cement mortar, the upper half of the ring bedded in this cement and carefully pointed, and the branch is then ready for connection.

An entirely different problem presents itself when the street sewer is constructed of hub-and-spigot pipe. When connection must be made to such a sewer, if the method first described is not followed, the following method is generally resorted to: A length of pipe where the branch is to be inserted is carefully broken so as not to injure the two adjacent lengths, the fragments of pottery are removed from the sewer and everything made ready for inserting the Y branch.

The top part of the hub on the branch fitting also the top part of the hub or the adjacent pipe are broken away as shown in the illustration (Fig. 8).

The bottom parts of the hubs are then carefully cleaned and covered with cement ready to bed the fitting in.

The Y branch, turned upside down, so the branch is at the right side of the pipe as shown in the illustration, is slipped down into place and the fitting revolved on its center axis until it occupies the position it will occupy to the sewer. This brings the

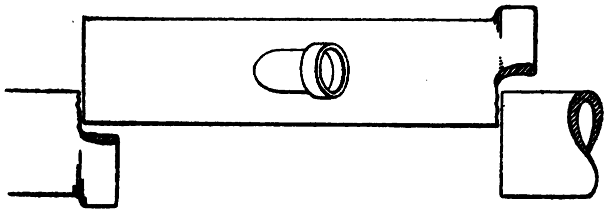


Fig. 8.

broken parts of the hub to the top again where it can be repaired and revolves the unbroken part of the hub to the under side of the drain. The joints can then be cemented, the pieces broken from the hubs, which should have been preserved for this purpose, may then be bedded in cement in their respective places and the branch is ready to be connected to. The sewer pipes are made in two grades or weights and in sizes ranging from 3 inches in diameter to 36 inches, known as standard and double strength. Pipes smaller than 4 inches in diameter are not used for sewers into which water closets discharge.

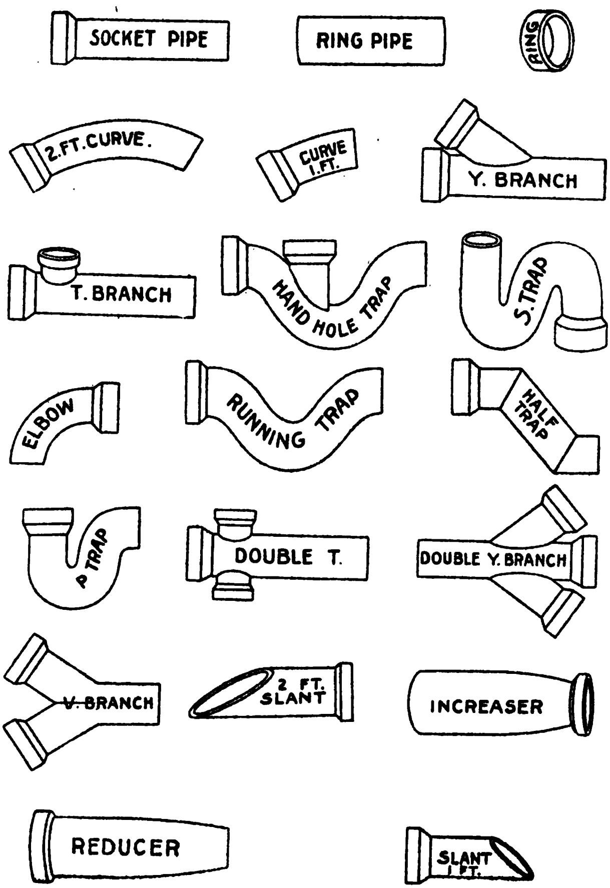

SOCKET PIPE
RING PIPE
RING
2.FT.CURVE.
CURVE 1.FT.
Y. BRANCH
T. BRANCH
HAND HOLE TRAP
S.TRAP
ELBOW
RUNNING TRAP
HALF TRAP
P TRAP
DOUBLE T.
DOUBLE Y. BRANCH
V. BRANCH
2 FT. SLANT
INCREASER
REDUCER
SLANT 1 FT.

Fig. 9.

SEWER PIPE FITTINGS.

The fittings used in sewer work are not as numerous as the fittings required for iron pipes. Stock sewer pipe fittings are shown in Fig. 9.

The straight length of pipe, also the branch fittings are manufactured in units two feet also three feet in length. The names of the various fittings are appended so that they will be understood at a glance. Except in the case of the increaser and reducer, the use of the other fittings are quite apparent. The reducer, as the name would imply, is used to reduce the size of a pipe line from one dimension to a smaller one. The increaser, on the other hand is used to increase the size of a pipe line from one diameter to a larger one.

INSTALLING HOUSE DRAINS.

Before cementing a length of tile sewer pipe or a tile fitting in a drain, the workman should assure himself that the pipe is in good condition, and is sound, straight, free from cracks, of uniform cross section and glazed over the entire inner and outer surface. The crooked and warped condition of a pipe can best be determined by sight, while the soundness can be determined by holding the pipe by one end in the hand and striking it a good sharp blow with a cold chisel or some other metallic instrument. If the pipe is sound and uncracked it will give forth a sharp metallic ring, while if cracked or broken it

will emit a dull sound. Having selected the pipe and fittings in the manner just described, and having the trench prepared so the pipes will bear the entire length on undisturbed earth, and having the soil scooped away where the hubs will lay, the operation of actually laying the pipe begins. Manufacturers of sewer pipes offer the following direction for laying tile pipe:

LAYING TILE PIPE.

"Commence at the lower end or outlet of the proposed drain, and grade the trench with a uniform inclination throughout its length. After excavating the bottom of the trench to a true uniform grade excavate a suitable depression for each socket so that the body of the pipe when laid will have a full, firm bearing on the ground. Commence laying the pipe at the outlet with all sockets facing up grade.

"For waste or drain pipes where perfectly tight joints are not required, the pipe can be used without filling in sockets, but where tight joints are necessary use cement mortar made of one-half each cement and good sharp sand. Soft clay can also be used for filling joints but mortar is of course better. When mortar is used be sure to carefully wipe inside of pipe so as to leave a smooth surface, free from projections or lumps at the joints.

"It is most important that pipe be laid on a solid bearing throughout its entire length and that the

sides be carefully rammed to distribute the pressure evenly over the entire surface of pipe.

"In laying sizes from 8-inch up it is safer to dig a narrow trench, say 6 to 8 inches wide and 3 to 6 inches deep, according to size, in middle of trench, with depressions for sockets as advised above. The pipes being laid in this manner will be sure of firm bearing along the sides and if loose earth is well packed and rammed from this bearing up to a point above center line of pipes, they will stand almost any amount of pressure."

Fig. 10.

KEEPING INSIDE CLEAN.

When laying the pipe it is necessary to keep a scraper of some description inside of the pipe to scrape out any cement which enters the pipe at the joints and which, unless removed, will set and form hard sharp points to catch and retain any solid matter passing through the drain. A simple scraper for this purpose is shown in Fig. 10. This tool is usually provided with a handle about 3 feet long and after each length of pipe is laid the cement is scraped out of the pipe before laying the next length.

CUTTING TILE PIPE.

Sometimes it is necessary to cut a length of pipe or a branch fitting before it can be set in place. Tile pipe can be cut by laying it on a bed of earth so the pipe will have a firm bearing along the line where it is to be cut, then with a cold chisel and a light hammer cut a groove all around the pipe and continue deepening the groove until the pipe separates at the constriction. If care is exercised not to strike too hard the tile pipe can easily be cut any desired length without cracking the end of the pipe.

PACKING JOINTS.

Some specifications require that the joints of tile pipe be made by first packing with a ring of oakum and then filling the hub with cement, mixed neat or with a certain proportion of sand. When such a requirement is in the specification, time can be saved by placing the pipe in the trench in place and packing all the joints at one time, after which they can be cemented.

ESTIMATING COST OF PIPE.

There is various information about tile sewer pipe which is of value when estimating the cost of sewers. For instance, when the number of lineal feet of any size of tile pipe is known, in order to estimate intelligently the cost of installation, the weight of the pipe should be known so

the cost of freight and draying can be calculated. The approximate weights and dimensions of various sizes of standard and double strength pipe, also the approximate weight and dimension of standard and double strength deep and wide socket pipe can be found in the following table:

TABLE I.

STANDARD SEWER PIPE.

Calibre, inches.	Thickness. inches.	Weight, per foot, pounds.	Depth of sockets, inches.	Annular space, inches.
2	7-16	5	1½	¼
3	½	7	1½	¼
4	½	9	1⅝	⅜
5	⅝	12	1¾	⅜
6	⅝	15	1⅞	⅜
8	¾	23	2	⅜
9	13-16	28	2	⅜
10	⅞	35	2⅛	⅜
12	1	43	2¼	½
15	1⅛	60	2½	½
18	1¼	85	2¾	½
20	1⅜	100	3	½
21	1½	120	3	½
22	1⅝	130	3	½
24	1⅝	140	3¼	½
27	2	224	4	¾
30	2⅛	252	4	¾
33	2¼	310	5	1¼
36	2½	350	5	1¼

TABLE II.

DOUBLE STRENGTH PIPE.

Calibre, inches.	Thickness, inches.	Weight, per foot, pounds.	Depth of sockets. inches.	Annular space, inches.
15	1¼	75	2½	½
18	1½	118	2¾	½
20	1 2-3	138	3	½
21	1¾	148	3	½
22	1 5-6	157	3	½
24	2	190	3¼	½
27	2¼	265	4	¾
30	2½	290	4	¾
33	2⅝	335	5	1¼
36	2¾	375	5	1¼

TABLE III.

DEEP AND WIDE SOCKETS, STANDARD.

Calibre, inches.	Thickness, inches.	Weight, per foot, pounds.	Depth of sockets. inches.	Annular space, inches.
4	½	10	2	½
5	⅝	12	2¼	⅝
6	⅝	16	2½	⅝
8	¾	25	2¾	⅝
10	⅞	37	2¾	⅝
12	1	45	3	⅝
15	1⅛	70	3	⅝
18	1¼	90	3¼	⅝
20	1⅜	115	3½	⅝
21	1½	130	3⅝	⅝
22	1⅝	145	3¾	⅝
24	1⅝	150	4	⅝

TABLE IV.

DEEP AND WIDE SOCKETS, DOUBLE STRENGTH.

Calibre, inches.	Thickness, inches.	Weight, per foot, pounds.	Depth of sockets. inches.	Annular space, inches.
15	1¼	75	3	⅝
18	1½	118	3¼	⅝
20	1 2-3	138	3½	⅝
21	1¾	148	3⅝	⅝
22	1 5-6	157	3¾	⅝
24	2	190	4	⅝

When estimating the cost of tile pipe laid in the trench, it should be remembered that the pipe is brittle and easily broken and due allowance should be made for pipe that is cracked in transit, defective, or becomes broken when installing. The amount of pipe condemned for such reasons varies naturally with the distance the pipe is shipped, the care with which it is packed and handled and the number of times it is handled, the condition of the pipe when shipped, and the requirements of the specifications and the superintendent in

charge. The amount of condemned pipe might vary anywhere from two to ten per cent and should be allowed for in the estimate.

CEMENT REQUIRED IN LAYING PIPE.

Having the length and size of sewer to be laid, the cement required to lay the pipe should be determined. This can be easily ascertained by reference to Table V, which gives the length of various size tile sewers that can be laid with one barrel of Portland cement.

TABLE V.

LENGTH OF PIPE ONE BARREL OF CEMENT WILL LAY.

	Size of pipe in inches.							
	6	8	10	12	15	18	20	24
Length in feet..	1,200	675	450	300	190	130	100	70

LEVELING TILE PIPE.

When leveling tile pipe to insure the drain having a fall from one end to the other, the level should be applied from hub to hub of the pipe, not placed on the length of sewer pipe. It is even better practice to use a straight edge or a leveling board which will reach several hubs at one time. By this means not only will a fall be insured the entire drain, but if all hubs are in line with the straight edge or leveling board, the drain will have a uniform fall. The objection to leveling a drain by applying the level to the several lengths of pipe lies in the fact that if the pipes are not concen-

trically entered in the several hubs, the level might show a good fall per foot when as a matter of fact the entire drain might be level, or in extreme cases pitch the wrong way. For instance, if a pipe be inserted in a hub as shown in section in Fig. 11, the pipe *a* might have a fall in the direction the drain discharges while as a matter of fact the hub *b* is lower than the hub *c*. This principle of leveling pipes applies not only to tile pipe but to a lesser extent to cast iron pipe, but in the latter case the danger of error is less owing to the greater length of cast iron soil pipe.

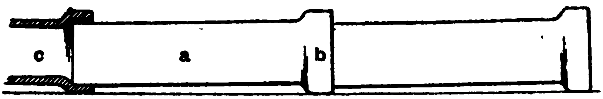


Fig. 11.

WHERE TO USE TILE SEWER PIPE.

Most city ordinances governing the plumbing and drainage of buildings specify under what conditions tile sewer pipe may be used. Most plumbing codes prohibit the use of tile pipe for main house drains inside of buildings, and for house sewers where they pass within 10 feet of a well, cistern, or other source of water supply or storage; when laid or built in ground, or when so near the surface of the ground that the sewer is likely to be exposed to the action of frost.

In cities where tile house sewers are permitted under all conditions, also in cities where the use of tile pipe is restricted by some conditions, they uniformly require that the tile pipe end from 5 to 10 feet outside of the foundation wall of the building and that cast iron pipe be extended from that point to the inside of the building, where the house drain may be either of cast iron pipe or of wrought pipe. Most city plumbing ordinances require in buildings where boilers are located, that a tile Y branch fitting be inserted in the house sewer outside of the foundation wall so the overflow from the boiler blow-off can discharge into it without passing through any portion of the iron pipe main house drain.

When the house sewer is completed, and before it is concealed from sight by refilling the trench, it is generally tested in the presence of a sewer inspector, plumbing inspector, or architect's superintendent. Usually the plumbing specifications under which the work is executed, stipulate the manner of testing the drain.*

Sometimes the plumbing code for the city requires that all tile sewers shall be tested in a standard manner; at all events, on good work executed under the supervision of a careful architect, the house sewer must be tested, and it may be done either by smoke or by water. The usual manner of

*"A Complete Guide to Testing Plumbing, Drainage and Gas Piping," by John K. Allen, is published by "Domestic Engineering," of Chicago, and sells at 50 cents.

testing a drain by water is to plug the sewer at its lower end by inserting a testing plug. The type of plug best suited to this purpose is shown in Fig. 12. It consists of a soft rubber ring which is expanded against the inner perimeter of the pipe by screwing down the winged nut on the stem. When

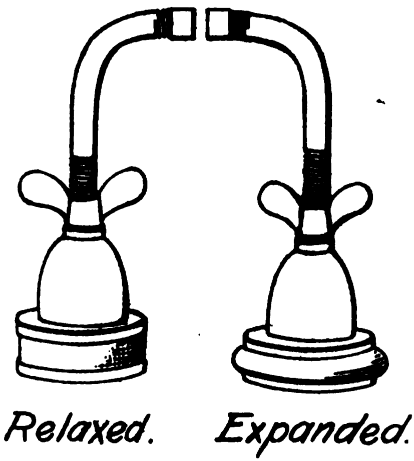


Fig. 12.

the sewer is properly plugged, it is filled with water to a point about two and one-half feet above the top of the sewer. A quarter bend cemented to the upper end of the sewer and looking upward, and a length of pipe cemented into the bend are sometimes used to produce the "head." A better way, however, is to use a testing plug with a filling cock

at the upper end of the drain through which to fill the sewer and have a short length of iron pipe and a funnel connected to the testing plug or filling cock so a pressure of water equal to the head or length of pipe and funnel can be produced. When such an arrangement is resorted to a vent cock must be provided through which the air in the sewer can escape when the water flows in. When the sewer is filled with water any leaks in the joints or pipe will be shown by water flowing from them and wetting the pipe and trench. The only way to repair the leaks is to draw off the water from the sewer, recement the defective joints, substitute new lengths of pipe for defective ones, and allow the pipe and joints to stand undisturbed until the cement is set before filling again to test the sewer. As long as leaks develop, this operation must be repeated, until the sewer stands under the head without showing signs of leak.

The water test in many ways is a severe one for a sewer pipe, and when the head is great or the sewer a long one it is a difficult test for tile pipe to withstand. In addition to the pressure due to the head at the upper end of the sewer, the pipe and joints at the lower end must withstand an additional pressure equal to that due to a head such as is contained in a sewer of the length constructed. For instance, if a sewer 100 feet long is laid at a grade of 1/4 inch to the foot, there would be a total fall

of $100 \times \frac{1}{4}$ inch equals 25 inches, or 2 feet 1 inch; added to the 2 feet head at the upper end of pipe would produce a pressure equal to a head of 2 ft. 1 in. +2 feet =4 feet 1 inch at the lower end of the sewer.

The smoke test is a less severe method of testing a house sewer. The smoke test is applied by plugging the inlet and outlet to the sewer, then pumping the pipe full of a dense, pungent smoke. The smoke can be introduced through a filling cock in one of the testing plugs. If leaks exist in the house sewer, smoke will be seen issuing from the crevices, when a sufficient pressure has been produced. The pressure produced by a smoke testing machine seldom exceeds that due to a head of two inches of water; it is sufficient, however, to develop any defective work or material in the sewer without exerting enough pressure to start leaks. The pressure from a smoke machine is not only light, but it is distributed uniformly regardless of the head or fall to the sewer, and for most house sewers, which do not pass close to a well, river, street, cistern or basement of another building, if they will withstand a smoke test they will be found sufficiently tight for most practical purposes.

SIZE AND FALL FOR SEWERS.

House sewers should have a uniform fall throughout their entire length, and the fall should be proportioned to the size of the pipe. It is desirable for

the sewage flowing through a sewer to have a velocity of about 270 feet per minute, and, as the friction of flowing liquids in pipe varies as the square of their diameter, it follows that pipes of small diameter must have a greater inclination than pipes of large diameter to produce an equal velocity of flow. The greater fall in the smaller pipes is equal to an increased head which offsets the greater amount of friction in the smaller pipes.

The proper fall for pipes ranging in size from 2 inches diameter to 10 inches diameter can be found in Table VI. Pipes of larger diameter than 10 inches are seldom used for house sewers.

TABLE VI.

FALL FOR DRAINS.

Diameter of drain in inches	2	3	4	5	6	7	8	9	10
Length in feet to 1-ft. fall	20	30	40	50	60	70	80	90	100

PIPE SIZES FOR HOUSE SEWERS.

The size of pipe to be used for a house sewer is seldom given proper consideration by those charged with the duty of installing it. It does not seem to be generally known that a sewer can be too large as well as too small, and that to err one way is as bad as erring the other. A house sewer should be large enough to carry off, within a reasonable time, the largest quantity of water that will ever be discharged into it, while at the same time it should not be so large that during ordinary flow it will fail to

float and carry along the solid matter it holds in suspension. If the water in a sewer is so shallow that the floating solids touch the sides or bottom of the pipe, the velocity of the solids will be retarded by the contact, and the water will drain away leaving the solids deposited in the pipe. The quantity of water which would be insufficient in a 10-inch pipe to carry along the solids would be sufficiently deep in a 6-inch pipe to float the solids without allowing them to come in contact with the pipe. A house sewer with a diameter of 4 inches is generally sufficient for an ordinary dwelling, or, in fact, for almost any building in a small town. There is no wisdom in constructing a house sewer out of pipe large enough to drain a sewer district in a city, and the only reason why such practice is ever resorted to is the mistaken belief that the larger a sewer the greater the capacity, hence the better for all purposes, and the house sewer in some buildings is made several times too large in order, as the designer believes, to make it "large enough."

The capacity of sewers ranging in size from 3 to 36 inches diameter can be seen in Table VII. It will be observed that a 4-inch pipe has several times the capacity that will be required for any ordinary building.

NEW YORK CODE PROVISION.

The plumbing code for the city of New York requires that the house sewer and the main house

drain for buildings into which rain water from the roof or other impervious surfaces discharges, be of the size specified in Table VIII.

TABLE VII.

CAPACITY OF TILE SEWERS.
Gallons discharged per minute.

Size of pipe in inches.	1-in. fall per 100 ft.	2-in. fall per 100 ft.	3-in. fall per 100 ft.	6-in. fall per 100 ft.	9-in. fall per 100 ft.	1-ft. fall per 100 ft.	2-ft. fall per 100 ft.	3-ft. fall per 100 ft.
3	9	12	15	22	27	31	44	54
4	20	28	35	50	62	71	101	124
6	63	89	111	156	194	224	317	389
8	140	198	246	348	432	499	706	804
9	196	277	339	480	595	687	971	1,180
10	261	369	457	698	803	928	1,310	1,610
12	432	612	758	1,070	1,330	1,530	2,170	2,660
15	800	1,130	1,400	1,980	2,450	2,830	4,010	4,910
18	1,320	1,860	2,310	3,260	4,040	4,660	6,590	8,080
20	1,720	2,500	3,060	4,330	5,305	6,130	8,660	10,610
24	2,910	4,110	5,035	7,191	8,810	10,270	14,520	17,790
27	4,020	5,680	6,960	9,840	12,050	13,920	19,680	24,110
30	5,380	7,618	9,320	13,180	16,140	18,640	26,350	32,280
33	6,950	9,840	12,050	17,040	20,865	24,090	34,070	41,730
36	8,800	12,450	15,210	21,565	26,410	30,500	43,130	52,820

TABLE VIII.

SIZE OF HOUSE DRAINS REQUIRED BY NEW YORK CODE.

Diameter of pipe.	Sewer laid at grade of ¼-inch per ft.	Sewer laid at grade of ½-inch per ft.
6 inches......	5,000 sq. ft. drain. area	7,500 sq. ft. drain. area
7 inches......	6,900 sq. ft. drain. area	10,300 sq. ft. drain. area
8 inches......	9,100 sq. ft. drain. area	13,600 sq. ft. drain. area
9 inches......	11,600 sq. ft. drain. area	17,400 sq. ft. drain. area

HOW SEWER TRENCH SHOULD BE FILLED.

When the house sewer has been completed and tested to the satisfaction of the inspector in charge, the trench is ready to be filled. Care should be exercised in filling the trench not to disturb the pipe. The best way to fill is to shovel in dirt containing no stones, to a depth of about 12 inches above the sewer pipe, then settle the earth firmly in place by wetting it with water from a hose. Instead of settling the earth by wetting, it may be tamped in place by heavy tamping tools, but the earth is never so well packed by tamping as it is by wetting, besides, when the earth is settled by wetting, the moisture in the trench will prove beneficial to the cement joints while setting and prevent their cracking. It might well be said in this connection that if a line of tile sewer pipe must be left exposed to sun and weather for some time before the trench is filled, the sewer should be covered with boards or with a tarpaulin to exclude the sun and prevent the wind from evaporating the moisture from the cement joints.

After the sewer pipe is covered to a depth of 12 or more inches there is little liability of breaking the pipe or joints, and rocks can be returned to the trench for filling. Water from the hose should be kept playing in the trench while the filling is going on, until the earth has reached the level where the water service pipe will be installed; the work of

filling the trench should then be suspended until the water main has been tapped and the service pipe run, after which the balance of the trench can be filled.

TWO METHODS OF EXCAVATING AND FILLING.

Before leaving the subject of excavating and refilling trenches it might be well to touch upon two methods which are not generally known and employed, but which under the right conditions may be employed to advantage. The methods referred to are respectively boring and tunneling.

In cities built upon a blue clay subsoil, as Chicago is, or upon any other kind of earth which will retain its shape and not cave under light pressure, a good way to trench for water service pipes, particularly when pipes are of lead, is to dig sections of the trench to the full depth and about 15 feet apart along the line to be opened, then with an ordinary 2-inch earth auger bore a hole from one pit to another and from that to the next until an opening for the pipe is provided from the water main clear through to the cellar of the building to be supplied. In order to bore a hole fifteen or more feet in length the auger must be made up in sections. This is usually done by constructing the handle of ⅜-inch or ½-inch iron pipe put together in pieces about 5 feet long which can be screwed together by couplings. The couplings should have loose

threads and the male threads on the pipe sections should be long or running threads so that when the sections are made up the ends of the two adjoining pieces of pipe will butt together, thus taking the strain off of the threads on the pipe and in the couplings. The end piece of the handle is usually made out of a T fitting screwed on the handle "bull headed" and the two short cross pieces screwed in the run of the fitting to serve as a handle. In using the auger it must be turned always to the right even when withdrawing the auger from the bore; by this means it will be impossible to lose the auger in the bore hole.

STRINGING THE PIPE.

When the pits and bore holes are all completed, by the exercise of a little care, the pipe can be strung through the bore holes from the pits clear from the water main into the cellar of the building, or, until the entire coil of pipe is strung out. To string the pipe, first pinch the end together with a pair of pliers, so the pipe will not fill with dirt while being strung in place. Next straighten out a section of pipe as long as the boring pit and insert it in the bore hole. When the straight section of pipe has been strung in place, straighten out another section in true alignment with the first section and push that in the bore hole; repeat the process until the end of the pipe emerges from bore hole

number one into the second pit. Here an assistant should be stationed to take the end of the pipe and guide it into the bore hole on the opposite side of the pit and help push the pipe through into the next pit.

Wrought iron or steel pipe can be strung in a trench through bore holes in much the same manner as lead pipe. When wrought pipe is to be installed, however, one of the pits, either at the center of the line of pipe or at one end, should be made sufficiently long to permit the entering of a length of pipe without bending. The several lengths of pipe should then be temporarily capped, to keep dirt out of the lengths while being shoveled through the bore holes, and should be strung in place throughout the entire length of the pipe line, care being taken to so arrange the lengths that couplings will be located in the pits, where they will be open for inspection when water is turned on to test the line. A good way is to lay out the pipe along the ground near the trench pits so the various lengths can be arranged and rearranged to the best advantage. With a little experience and by exercising care a workman can string lead pipe from pit to pit located from 15 to 25 feet apart and, were it not for the fact the couplings on iron pipe should be exposed to view to make sure they are tight iron pipe could be strung even a greater distance.

HOW TO TUNNEL FOR SEWER PIPE.

Tunneling for sewer pipe is resorted to under two conditions. When the house sewer must be carried through a ridge of high land which would necessitate digging a trench fifty or more feet in depth, it will be found cheaper in many cases to sink two or more shafts to work from and tunnel through the high ridge of earth.

When tunneling for a sewer, great care must be exercised to prevent the earth from caving in and burying the workmen. To prevent caving it is customary to line the tunnel with planks just as fast as the tunnel is constructed, and remove the planking again as the work of filling in progresses. As the part of the sewer which is buried in the tunnel is very inaccessible and cannot be reached for repairs without great cost, it is needless to say that greater care should be exercised installing this section of pipe than would be required for ordinary house sewers.

The other condition under which tunneling is resorted to when installing a house sewer is when a trench is to be cut through flower beds, or will disturb the roots of trees or otherwise disarrange or perhaps destroy vines, trees or shrubbery in a garden or lawn. Under such conditions the line of trench is stalked off and pits sunk at frequent intervals along the line of trench.

Tunneling cannot be successfully resorted to in

shallow trenches through loose soil that will easily cave, but may be successfully performed in close compact earth that will hold its place when undermined. When filling the earth in a combined trench and tunnel the earth should be well rammed into the tunnels so that a subsequent settlement of the earth above the trench will not defeat the very object of tunneling in shallow trenches by disturbing the surface of the ground.

WATER SERVICE PIPE.

The water mains in city streets usually belong either to a water company or to the municipality. In the latter case they are under the care of a board of water commissioners who have full jurisdiction over them. In either case it is important to know when and where connections are made to the street mains, and to serve as a check against illegal tapping of the water mains, as well as to furnish a record of the number of taps being supplied, the board of water commissioners or the water company, as the case might be, require that a permit shall be obtained before a tap is made, and, when all formalities have been complied with, an employe of the company or the city makes the tap.

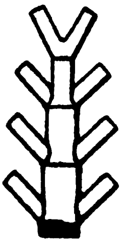


Fig. 13.

Owing to the curvature to the water pipe a tap of larger diameter than ¾-inch is seldom per-

mitted, consequently when a larger service pipe than ¾-inch is required, the water main must be cut and a special branch fitting inserted, or, as an alternative, a number of taps can be inserted in a row, and lead tailpieces from the taps connected to a common multiple fitting as shown in Fig. 13 of the full size of the service pipe.

CORPORATION COCKS.

There are two types of corporation cocks used for connecting to street mains. They are known respectively as "screwed" corporation cocks and as "driven" corporation cocks. A "screwed" corpora-

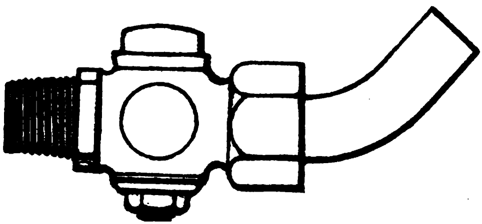


Fig. 14.

tion cock, an illustration of which is shown in Fig. 14, has a thread cut on its outer surface which fits and is screwed into a corresponding female thread tapped in the water main. The operation of tapping a water main is performed while the pipe is full of water and under pressure, and is accomplished with the loss of but little water. A tapping machine, Fig. 15, is secured to the pipe by

clamps and a hole of the right size for tap is drilled through the pipe by a drill which is enclosed in a water tight compartment. When the hole is drilled the drill is removed from the ratchet, a tap substituted and the hole, previously cut through the pipe with the drill, is tapped with a screw thread. The tap is then removed, the corporation cock substituted in its stead, and screwed far enough into place so the machine can be removed and the cock screwed down tight by means of a wrench.

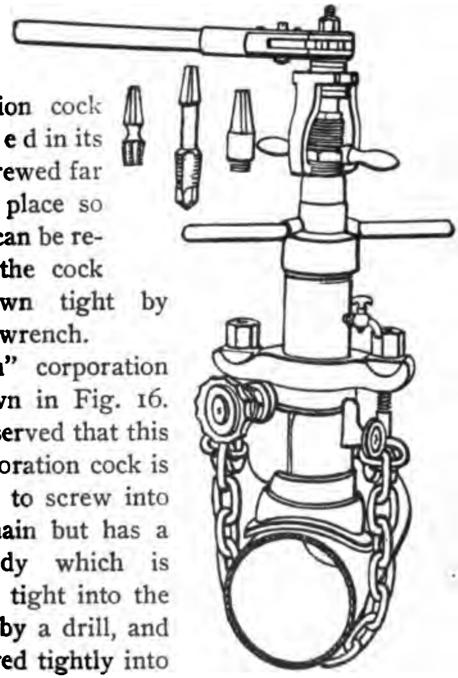


Fig. 15.

A "driven" corporation cock is shown in Fig. 16. It will be observed that this form of corporation cock is not threaded to screw into the water main but has a tapering body which is driven down tight into the opening cut by a drill, and is thus wedged tightly into place. The method of tapping a water main for a driven corporation cock is

about the same as for a screwed corporation cock, except that for the driven cock the water main is not tapped with a screw thread. Instead, when the hole has been tapped in the water pipe the corporation cock is driven in sufficiently hard to hold while the tapping machine is being removed, when it is driven down hard by a hammer. Screwed

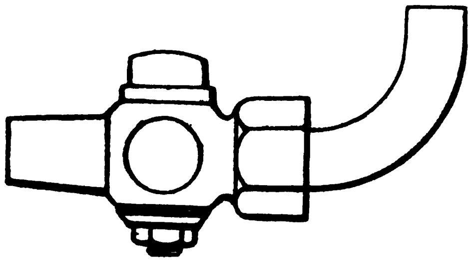


Fig. 16.

corporation cocks are used far more extensively than are driven corporation cocks, and are a better type of connection for water mains. The amount of water lost by leakage around driven corporation cocks is considerable, and is proportioned to the pressure of water within the mains.

A coupling is provided for, and usually forms part of every corporation cock. The coupling is made for a wiped joint to lead pipe, as that is the most approved way of connecting a service pipe to a water main. Wrought pipe deteriorates very quickly when buried in the earth, for which reason

lead service pipes are usually installed in localities where the water will not be affected by passing through lead pipe. In localities where iron service pipe is used a short tailpiece of lead pipe from 18 inches to 3 feet in length is used to connect the iron service pipe to the water main. This short piece of lead pipe is laid wavy in the ground to allow for settlement in either the service pipe or the water

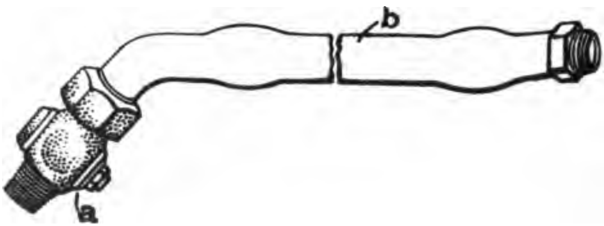


Fig. 17.

main, without injury to the connection. A connection for a street main is shown in Fig. 17. In this illustration the corporation cock *a* is of the screwed type, and the short piece of lead pipe, *b*, which connects the service pipe to the corporation cock, is laid wavy to allow for settlement of the pipes or trench.

CURB COCKS.

In most cities a curb cock is put in the service pipe so that water can be shut off from the building it supplies without entering the premises or

digging down to the corporation cock. A curb cock, as the name would imply, is simply a cock located near the curb line and provided with means for shutting off or turning on the water without disturbing the surface. An ordinary round-way stop cock is generally used for this purpose, but where a lasting installation is required it is well to use a heavy pattern round-way cock.

An extension shut-off box, similar to the one shown in Fig. 18, is generally used at the curb to enclose the stop cock and make it accessible. Sometimes a clamp with a rod extending to the top of the box is wired to the stop cock handle so that the rod can be turned with a wrench or a pair of pliers. In other work, on the other hand, only the box is set in place, and a long-handled portable key must be used for shutting off or turning on the water. The top of the box should be provided with a cover that cannot easily be lost or displaced, so the box can be filled with dirt, snow or stones accidentally falling in, or maliciously put in by children.

CAPACITY OF SERVICE PIPES.

The discharging capacity of various sizes of pipe, ranging in diameters from ½ to 6 inches, when subjected to various back pressures can be found in Table IX. This table was compiled for the Thomson Meter Company by Mr. Kuichling. In the calculations, resistance due to friction was omit-

ted, and the conditions referred to by Nos. 1, 2, 3 and 4 are as follows: In No. 1 the water discharged through 35 feet of horizontal pipe, with no back pressure; No. 2 discharges through 100 feet of horizontal pipe and against no back pressure; No. 3 discharges through 100 feet of horizontal pipe and against a back pressure due to a head of 15 feet, and No. 4 discharges through 100 feet of horizontal pipe and against a back pressure due to a head of 30 feet.

REPLACING PAVEMENT AND SOD.

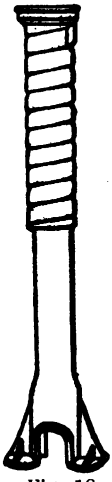


Fig. 18.

When the house sewer and water service pipe have been installed and the trench filled, the pavement and sod must be replaced. It is customary, however, to heap a little mound of earth above the trench and temporarily repair the pavement until the earth has settled back into place, when the pavement can be permanently replaced. The work of permanently replacing the pavement is done by employees of the city, acting under the supervision of the Department of Highways, and the fee exacted for opening the street is supposed to cover this item of cost. In like manner, the trench through a lawn has the superfluous earth heaped above it until the earth in the trench has

settled into its final bed, when the trench can be leveled off and the sod replaced. It might be well to mention here that the top soil which was saved when digging the trench should be returned to the trench at the top, and if the sewer pipe installed be a large one it might be well to cart away some of the under strata of earth, sufficient in quantity to equal that displaced by the pipe.

TABLE IX.

Condition of discharge.	Pressure in main, pounds per square inch.	CAPACITY OF SERVICE PIPES. Discharge, in cubic feet per minute, delivered from pipe under conditions stated. Nominal diameters, in inches, of iron or lead service pipes.								
		½	⅝	¾	1	1½	2	3	4	6
No. 1.	30	1.10	1.92	3.01	6.13	16.58	33.34	86.16	173.85	444.63
No. 1.	40	1.27	2.22	3.48	7.08	19.14	38.50	101.80	200.75	513.42
No. 1.	50	1.42	2.48	3.89	7.92	21.40	43.04	113.82	224.44	574.02
No. 1.	60	1.56	2.71	4.26	8.67	23.44	47.15	124.68	245.87	628.81
No. 1.	70	1.74	3.03	4.77	9.70	26.21	52.71	139.39	274.89	703.03
No. 1.	100	2.01	3.50	5.50	11.20	30.27	60.87	160.96	317.41	811.79
No. 1.	130	2.29	3.99	5.28	12.77	34.51	69.40	183.52	361.91	925.58
No. 2.	30	.66	1.16	1.84	3.78	10.40	21.30	58.19	118.13	317.23
No. 2.	40	.77	1.34	2.12	4.36	12.01	24.59	67.19	136.41	366.30
No. 2.	50	.86	1.50	2.37	4.88	13.43	27.50	75.13	152.51	409.54
No. 2.	60	.94	1.65	2.60	5.34	14.71	30.12	82.30	167.06	448.63
No. 2.	75	1.05	1.84	2.91	5.97	16.45	33.68	92.01	186.78	501.58
No. 2.	100	1.22	2.13	3.36	6.90	18.99	38.89	106.24	215.68	579.18
No. 2.	130	1.39	2.42	3.83	7.86	21.66	44.34	121.14	245.91	660.36
No. 3.	30	.55	.86	1.52	3.11	8.57	17.55	47.90	97.17	260.56
No. 3.	40	.66	1.15	1.81	3.72	10.24	20.95	57.24	116.01	311.09
No. 3.	50	.75	1.31	2.06	4.24	11.67	23.87	65.18	132.20	354.49
No. 3.	60	.83	1.45	2.29	4.70	12.94	26.48	72.28	146.61	393.13
No. 3.	75	.94	1.64	2.59	5.32	14.64	29.96	81.79	165.90	444.85
No. 3.	100	1.10	1.92	3.02	6.21	17.10	35.00	95.55	193.82	519.72
No. 3.	130	1.26	2.20	3.48	7.14	19.66	40.23	109.82	222.75	597.31
No. 4.	30	.44	.77	1.22	2.50	6.89	14.11	38.63	78.54	211.54
No. 4.	40	.55	.97	1.53	3.15	8.68	17.79	48.68	98.98	266.59
No. 4.	50	.65	1.14	1.79	3.69	10.16	20.82	56.98	115.87	312.08
No. 4.	60	.73	1.28	2.02	4.15	11.45	23.47	64.22	130.59	351.73
No. 4.	75	.84	1.47	2.32	4.77	13.15	26.95	73.76	149.99	403.98
No. 4.	100	1.00	1.74	2.75	5.65	15.58	31.93	87.38	177.67	478.55
No. 4.	130	1.15	2.02	3.19	6.55	18.07	37.02	101.33	206.04	554.96

PROTECTION OF TRENCHES.

It is of the utmost importance that trenches be protected, both for the safety of the public and for the welfare of the contractor. Any injury or damage to pedestrians, horses or vehicles, caused by negligence of those in charge of a trench excavation, lays the contractor open to a law suit at the least, with possibly heavy damages for the injury. Every obstruction temporarily placed in the street should have a red light at each end of the obstruction burning all night. That part of a house sewer trench which is outside of the building line should be covered every night before quitting work, with 2-inch planks resting firmly on crosspieces so the planks will not give way if weight is imposed upon them. Around the trench there should be constructed a barrier to keep trespassers from stepping on the platform covering the trench. This barrier is usually made by placing a barrel filled with stones, dirt or sand at each corner of the trench, and similar barrels about 10 feet apart along each side of the trench, then resting planks on these barrels, extending from one barrel to another, and weighting these planks down with stones. After nightfall a red lantern should be attached to each of the corner barrels, and when the trench is a long one an additional lantern should be placed every 10 or 12 feet, or every 20 feet, along each side, but the lights so distributed that they will be about 10 feet apart.

Many contractors cover any liability from loss due to accident by taking out a policy of insurance in one of the numerous casualty companies which make a specialty of insuring workmen on a building or loss or injury to property likely to arise from any hazardous or extra hazardous employment. That is a matter purely of judgment with the contractor, but when opening many trenches in busy thoroughfares it would seem a wise precaution to secure protection by such a policy. When not covered by a policy of insurance, many contractors employ a night watchman to keep the lights burning and otherwise look after a trench opening to see that no damage results, or to have one of their own men on hand as a witness should anything occur. Of course, a watchman is employed only on large constructions where the amount involved and length of time the trench will be open warrants the expense; but on many building operations a watchman is employed to guard the building at night, and under such conditions he takes care of the sewer trench also.

ESTIMATING THE COST OF A HOUSE SEWER.

When called upon to estimate the cost of the house sewer and the water service pipe the first thing to do is to prepare an itemized list of the various materials, permits and labor likely to be required, and fill out this list with the various quan-

tities and their cost. A sample list for such purposes is here given.

ESTIMATE HOUSE SEWER AND WATER SERVICE PIPE.

No.	Items. Cost.	Amount.	
	Permit to open street..................	$10	
	Permit to tap sewer..................	6	
	Permit to tap water main..............	5	
	Excavating and refilling (ten days' labor at $1.50 per day)..................	15	
	Sewer pipe and fittings (60 ft. 5-in. tile pipe at 20c ft., $12; 3 fittings at 50c $1.50)	13	50
	Cement, 60 lbs. at 5c.................	3	00
	Labor laying sewer pipe, 1 day mason at $4.00	4	00
	Lead pipe—20 lbs. lead pipe at 10c, $2.00	2	00
	Calking lead		
	Cast iron fittings......................		
	Galvanized iron pipe and fittings (60 ft. 1-in. pipe at 10c, $6.00; 1 lb. fittings at 25c, $6.25)......................	6	25
	Solder, 6 lbs. at 20c..................	1	20
1	Curb stock	1	25
1	Curb box	2	50
	Lights		25
	Watchman	8	00
	Insurance, or risk.....................	10	00
	Gasoline		30
	Powder or dynamite..................		
	Sharpening drills		
	Handling water......................		
	Freight and drayage..................	3	00
	Incidentals	4	00
		$89	25
	Operating expenses, 20 per cent.........	17	85
		$107	10
	Profit, 20 per cent.....................	21	42
	Estimate submitted..................	$128	52

EXPLANATION OF THE ESTIMATE.

In filling out the foregoing estimate the cost and quantities have all been assumed, to show how an estimate should be made. Of course, in an actual estimate the exact quantities would be ascertained

and the actual cost of the various goods determined and used. There are a few items in the estimate which will require explanation. The item "incidentals" is supposed to include the numerous little expenses incidental to doing work, which of themselves are not of sufficient moment to itemize. For instance, the oil used in cutting and threading pipe is a legitimate item of expense, but the amount used is too small to be considered separately. So are candles used for lighting the interior of the sewer to work by, and numerous other little items of cost which taken separately seem insignificant, but which taken collectively, particularly on a large job, amount to a considerable amount and should be considered in an estimate.

Another item, which might seem strange but which is as much legitimate cost as is the pipe used in the trench, may be cited in the combined cost listed under the title of "operating expenses." Every business has certain expenses attached to it, such as rent, light, heat, clerk hire, losses from bad accounts, insurance, wear and tear on machinery and tools, water rent, depreciation in value of office furniture, administrative salaries, legal fees and various other drains on the treasury which are directly chargeable to the business and must be borne by the contracts performed. Careful business men calculate each year this operating expense and determine what percentage it bears to the volume of work han-

dled, and use those figures as a basis on which to charge their operating expenses when estimating work or charging for work performed.

The charge of 20 per cent profit on the work can not be taken as a fair charge for all work, but is used here to show how profit is figured on work. On a large contract containing many fixtures, a charge of 10 per cent profit would probably be a fair one, while on work of a hazardous nature, such as street work, putting in house sewers and water service pipes, a charge of 35 per cent might not be excessive, particularly where there is any uncertainty as to the nature of the subsoil and a risk of losing on the contract seems possible.

THE HOUSE DRAIN.

Preparing for the Plumbing Work.

IN every building that is to be erected there are certain provisions to be made for the installation of the plumbing work, which if made in time, before work on the building has progressed too far, will not only reduce considerably the cost of the plumbing installation, but will insure a better job of plumbing, with less exposed piping and the minimum of cutting and repairing. So important are these preliminary provisions that in large buildings a plumber should be on the job from the time the foundations are started, to see that everything necessary for the plumbing work is done by the other workmen. Unfortunately, however, the plumbing contract is let on but very few buildings before the walls and roof enclosing them are completed, so that buildings which are properly cared for are the exception instead of the rule.

One of the most important provisions to be made for the plumbing work is to locate openings in the various foundation walls through which the main house drain, any of its branches, rain leaders, fresh air inlet and yard or area drain pipes are to pass.

Indeed, it is well to go even further and provide openings for hot, cold and circulation water pipes, so as to prevent subsequent cutting and patching of walls. Where the foundation walls are of brick, this requirement is not of so much importance as when walls are constructed of stone or of cement concrete. When walls are built of stone it is seldom that a small hole can be cut without making a large breach in the wall, which is difficult to patch in a workmanlike manner, while in a cement concrete wall, if the materials used be of good quality, the task of drilling or cutting a small hole is a most difficult one.

Great care must be exercised to get the proper levels before locating pipe holes. To get the proper levels the depth of the sewer in the street must be ascertained, if the house sewer is not already laid, and the proper amount of pitch or fall must be allowed from the opening in the foundation wall to the street sewer. For work requiring such accuracy it is better to use a surveyor's level than to depend on an ordinary spirit level and straight edge. If the house sewer be already laid, the matter of levels becomes much simplified, so far as the opening in the front foundation wall for the main house drain is concerned, and when that opening is located the locating of all other holes becomes much simplified.

Next in importance to locating all holes through foundation walls at their proper elevations is the

necessity for locating them at the right point in the various walls, so the several pipes can be installed without the use of unnecessary fittings, and so they will not be in the way of steam pipes, machinery or apparatus. To avoid burying drain pipes beneath steam boilers or heavy machinery of any kind it is well to consult the steam fitter's and refrigeration engineer's plans, to see that the location of pipe holes does not conflict with the location of steam apparatus or refrigeration machinery. Pipe holes are usually made sufficiently large to allow slight leeway up and down or to the sides. If the holes are above the basement floor, however, they should not be so large that they cannot be covered with a wall plate or escutcheon.

Holes through brick or stone walls for large size pipes to pass through should be arched over to prevent the wall caving in on the pipe. Small-size holes can be arched over with sufficient security by a brick or stone.

A good method of building holes through masonry walls which at the same time is rather inexpensive is to provide a short pier of extra strong cast iron pipe, one or two sizes larger than the pipe to be run, and have the pieces of pipe built into the walls at their proper locations by the masons. Odd pieces of pipe, which have been cut off from lengths, can be used for this purpose by cutting

them just the right length to fit in the wall where used.

Allowance should always be made for the settlement of walls and space left between the drain pipe and the top of the hole or sleeve so that the drain cannot be damaged by a settlement of the building. It naturally follows from what has just been stated that the space around drain pipes where they pass through a wall should not be filled with masonry. If filling of some kind is necessary to prevent the passage of drafts, bugs or cold, some yielding material should be used that would give under pressure, so the pipes cannot be broken.

In addition to holes through foundation walls, corbels are often provided for drain pipes to rest on. It is needless to say that as great accuracy is required in laying out corbels as would be required in locating other levels. Should the corbels be placed too high, they would, of course, be useless; while if placed too low, each corbel would have to be built up to the required height before it could be used.

In many large buildings, the main house drain and all its branches are run in pipe ducts built below the level of the cellar floor and covered over with flag stones or cast iron covers. The ducts to be built are usually shown on the mason's drawings; and, unless spoken to in time he will build them according to the drawings. If plumbing plans were

always prepared by a sanitary engineer, who would study the work in detail before incorporating the layout on the drawings, it would be all right to build the ducts as shown on the plans; but, the plumber will find, in many instances, that the layout can be vastly improved by a little study and he must then have the architect revise the drawings, or give instructions to the mason to make the necessary alterations to conform to the new layout.

It is of extreme importance to check up the elevation of the floor of the pipe ducts to see that they are sufficiently low to receive the drains. It is better to have the bottom too low than too high, for in the former case the pipe can be blocked up on bricks to the required level, whereas all other calculations would be thrown out of trial if the floor were built too high.

If pipes are to be run in chases in the brickwork care should be exercised to see that the chases are left in the right places and are of the required size. Usually bricklayers are careless or indifferent about their measurements and often locate a chase from four to six inches from the point marked on the plans, simply because it can be located at such a place without cutting the bricks.

For the same reason, chases are sometimes made smaller than are called for on the plans. Even though bricklayers were careful about their measurements and worked accurately to plans, care

would still have to be exercised for the reason that architects do not know the exact size and location of chases required by the plumbers, and simply indicate the approximate size and location on the plans, assuming that the contracting plumber will look after the details of construction.

So far, the provisions requiring consideration have been confined to the mason work. The carpenter work, however, requires an equal amount of thought and study to have properly prepared for the plumbing work. Very few plumbers give a thought about how they will get the lead roughing under the floors of bath rooms and toilet rooms until they are about ready to make a start, and then often find that sufficient space is lacking between the beams for the lead bend to be put in place. When such is the case, there are three different ways by which they can overcome the difficulty. First, they can have the necessary beams cut out and a header framed in to hold the ends of the cut beams in place. If, however, the owner objects to the cutting of beams, or for any other reason the beams cannot be framed, the necessary branch piping for the fixtures can be installed, either beneath the ceiling or above the floor beams. If the fixture branches are placed above the floor beams, it becomes necessary to step the floor of the bath or toilet room so as to conceal the piping; and stepping the floor of a room is objectionable from an architectural standpoint.

All after fuss or worry can be avoided by consulting with the carpenter foreman before the floor beams are in place and mark on his framing plans the size and location of the opening required for the lead roughing. When the pipes are installed and tested, the carpenters can fit beams in the space to carry the floor and ceiling.

The location and size of partitions is something that must also be watched. Carpenters are sometimes very careless about laying out partitions and often when partitions are marked on the plans to be placed one above another, the carpenters will vary two or more inches in their measurement, so that partitions will be that much off line. This deviation from the plans not only affects the layout of fixtures in small bath or toilet rooms, but if stacks of soil, waste, or vent pipes are to be carried up in the partition, if concealed in one story they will be exposed in others when the partitions are not properly aligned.

The thickness of some partitions affects, to a greater or less extent, the plumbing in buildings. The average size of pipe used for soil stacks is 4 inches, while in some buildings stacks 5 inches and even 6 inches in diameter are used. The hubs on pipes are approximately two inches larger than the pipes, so that in order to have pipes and hubs concealed between the walls of a partition studding of the full width of the hubs must be used. That is,

for four-inch soil pipes, six-inch studding would be required, while for five and six-inch soil stacks eight-inch studding should be used.

Where space is limited, smaller sized studding than those recommended are often used and the hubs of the pipes allowed to stick through the lath and plaster. Obviously, however, that would be undesirable in anything but the cheaper grade of houses, for, in addition to the hubs showing, the plaster near the hubs usually becomes stained with rust. Wide partitions have advantages outside of concealing the pipes from view. Generally vent pipes have to pass by soil stacks in the partition and when large size studding are used the pipes can not only be roughed in in the minimum time, not having to work to close measurements, but when installed the pipes will not show through the plaster.

WORKING ROOM.

When the building construction is so far advanced that the actual work of installing the plumbing can begin, the plumber should look around and select a room or site which can be used as a workshop and headquarters on the job. Good judgment in selecting a workroom will cut down the actual time of the workmen by a considerable percentage, while a poor location will add considerably to the cost of labor. The workroom should be selected in a well lighted location, for without light no

workman can put forth his best efforts. The room should be close to the ladders, elevators or other means of communication with the several floors, and should not be exposed to extreme heat or cold, for comfort for the workmen is necessary if they are expected to do a good day's work. The room should be large enough so materials like wrought-iron pipe can be handled without interfering with the workmen, and a sufficient number of benches should be provided, so workmen will not lose time waiting for their turn at a bench or vise. A sufficiency of good tools is another requisite which should not be overlooked. More time is wasted on some jobs because sufficient tools are not provided for the workmen than would pay for a new outfit for each man every week. The writer distinctly recalls to mind one large plumbing contract in New York City where a sufficient quantity of tools was provided but they were of such poor quality as to be almost worthless. In order to cut threads on 2-inch pipe with the dies provided, the fitter first had to pass an endless rope through the pipe, then, after setting the stock and die in place, by putting a short piece of pipe through the loops at each end of the rope, so one piece of pipe would cross the end of the pipe to be cut while the other piece crossed the face of the die plate, and turning the stocks to the right, sufficient tension could be produced on the rope to draw the die onto the pipe. As

might be expected the energy wasted in cutting threads with such dies wore a man out before the day was done, while the threads could never be depended on to be perfectly tight. Much time is likewise wasted trying to work with wrenches or pipe tongs which are so worn that they will not grip the pipe, or, which, after gripping the pipe, will not let go so as to get a new hold.

For roughing-in the lead work in the several bath and toilet rooms, a light knock-down bench, which can quickly and easily be moved from floor to floor, is almost indispensable for each man. The inconvenience of working on the floor tires a workman much more than does working at a bench, besides retarding his movements to a considerable extent.

Besides a workroom, all large plumbing installations should have a stock room where brass goods, solder, lead and fittings and all the more expensive materials can be locked and given out only on requisition. In addition to the brass goods and materials, the foreman should be provided with a set of fixtures to be installed from which he can get all roughing-in measurements. Being provided with all the materials enumerated in the foregoing paragraphs, the plumber is ready for the actual work of installing the drainage system.

MATERIALS FOR THE HOUSE DRAIN.

Cast Iron Pipe.

THE material most commonly used for the house drain in buildings is cast iron hub-and-spigot pipe, put together with lead calked joints. So much better for this purpose is cast iron pipe than all other kinds of material that most cities where they have adopted a plumbing code, require that cast iron pipe be used for the house drain when buried under the floor of the cellar, although they permit the use of other materials when installed above the cellar floor.

Cast iron pipes suitable for drainage work is made in two grades, known to the trade as standard and as extra heavy, respectively. The pipes are cast in lengths of 5 feet each, exclusive of the hubs and are of the average weights per lineal foot, stated in the following table:

Inside Diameter of Pipe.	Average Weights per Lineal Foot, Including Hubs. Standard.	Extra Heavy.
2 inches..................	3½ pounds	5½ pounds
3 inches..................	4½ pounds	9½ pounds
4 inches..................	6½ pounds	13 pounds
5 inches..................	8½ pounds	17 pounds
6 inches..................	10½ pounds	20 pounds
7 inches..................	13 pounds	27 pounds
8 inches..................	18 pounds	33½ pounds
10 inches..................	25 pounds	44 pounds
12 inches..................	30 pounds	54 pounds
15 inches..................	45 pounds	....

The smallest cast iron pipe made is 2 inches in diameter and the largest 15 inches in diameter. Between these two extremes the sizes graduate by inches, there being a size of pipe for each inch above 2 inches except 9, 11, 13 and 14 inches. There is no 9, 11, 13 or 14-inch cast iron pipe made.

Soil pipe, as cast iron pipe used for drainage work is called, is cast in one of two different ways, and the quality of the pipe depends to some extent on the way it is cast. Soil pipe, which is cast on its side, that is, while the mold is in a horizontal position, is usually thin on one side and thick on the opposite side. Some lengths of pipe cast in that manner have so little metal on the thin side that they are easily cracked in handling and are extremely difficult to cut without breaking. In addition to being thin on one side, pipes which are cast in a horizontal position are usually more or less curved, so that it is difficult to run a straight length of drain with them. It might be well to state that the defects of pipe cast on the side are more noticeable in standard weight pipe than in extra heavy pipe.

To cast pipe on end, the flasks are stood in an upright position and the molds poured full of the molten metal. Any shrinkage then occurs from the top down and the pipe throughout is more of a uniform thickness and texture. Most of the soil pipe now made is cast on end, although there are foundries which still stick to the horizontal method.

As would be expected there is a great difference between the same grades of pipe turned out by different manufacturers. Some pipe is rough, coarse looking, full of mold marks and underweight, while other pipe is full weight, compact, of close texture, smooth and in every way to be preferred. The latter kind of pipe is less likely to crack when being handled or cut, and less likely to develop sand holes than the poorer quality and will consequently prove more economical to handle. The use of standard cast iron pipe is prohibited entirely in some cities, while in others its use is permitted, providing it will stand a water test. In cities where no restrictions are placed on the use of standard weight cast iron pipe it will be found perfectly safe to use in buildings not over three stories in height, providing the system is filled with water upon completion and made perfectly water tight. Standard weight pipe can be made perfectly water tight but when the greater care required to make it tight is considered it is doubtful if there is much economy in its use. Extra heavy cast iron pipe, on the other hand, can be used in any building of ordinary height and once made perfectly tight will remain so unless exposed to extremes of heat or cold, or other conditions likely to affect the joints.

Extra heavy cast iron pipe is invariably used for the house drain, in connection with the wrought pipe system of drainage, when the house drain is

buried in the earth under the cellar floor or run in pipe ducts built below the cellar or basement floor.

Cast iron pipe can be had either plain or coated with pitch, tar or asphaltum; much difference of opinion seems to exist, however, as to the wisdom of coating the pipes before they are installed. It is maintained by many that defects such as cracks and sand holes are concealed by dipping the pipes while hot into a molten preparation of tar or asphaltum and that in the course of time the preservative will become worn or broken away thus leaving a channel for the escape of gas into the building. While that position is true, those of opposite view claim that a rigid inspection supplemented by a water test will disclose any defects in a pipe or fitting, coating or no coating, and that the advantages of coated over uncoated pipe will more than offset the possibility of defective pipe being used. They point out that, with preparations on the market, uncoated pipes can be patched as readily as coated pipes; that coating pipes protects them from contact with sewage and earth, thus prolonging their life many fold; and that coating a pipe makes it smoother and less likely to retain putrescible matter on its surface, besides increasing the capacity of the pipes by reducing the frictional resistance to sewage passing through. Those who are opposed to the coating of pipes admit that coating would be beneficial to the pipes

if the pipes were all perfect, and in some cases recommend coating them on the outside (it being impossible to coat them on the inside) after the pipes have been tested. That the weight of opinion is against coating pipes is evidenced by the fact that most cities having a plumbing ordinance require that uncoated extra heavy cast iron pipe be used.

Within recent years the use of wrought-iron or steel pipe has become quite general in larger buildings in large cities. The use of wrought-iron or steel pipe, however, is usually confined to the stacks and branches of soil, waste and vent pipes, and used for the house drain only when located above the cellar or basement floor. When buried in the earth, the house drain is made of some more durable material and the upright stacks of wrought pipe, connected to the outlets above the floor. For drainage work, wrought pipe should be galvanized both inside and outside and should be equal to at least standard weight of pipe. In the extremely tall buildings extra strong pipe is used to a considerable extent, and in some places even double extra strong pipe is used. The weights and dimensions of standard extra strong and double extra strong wrought-iron and steel pipes are shown in the accompanying tables.

Plain wrought-iron or steel pipe which has been coated with tar or asphaltum is often used in the drainage system, but it is generally conceded to be inferior to galvanized iron pipe for this purpose.

Dimensions of Standard Wrought Pipe.

Diameter: Nominal Internal	Diameter: Actual External	Diameter: Approximate Internal Diameter	Thickness	Nearest Wire Gauge	Circumference: External	Circumference: Internal	Transverse Areas: External	Transverse Areas: Internal	Transverse Areas: Metal	Length of Pipe per Sq. Foot of: External Surface	Length of Pipe per Sq. Foot of: Internal Surface	Nominal Weight per Foot.
Ins.	Inches	Inches	Inches	No.	Inches	Inches	Sq. Ins.	Sq. Ins.	Sq. Ins.	Feet	Feet	Lbs.
1/8	.405	.205	.1	12½	1.272	644	.129	.033	.086	9.433	18.632	.29
1/4	54	.294	123	11	1.696	.924	.229	.068	161	7.075	12.986	.54
3/8	.675	.421	.127	10½	2.121	1.323	.358	.139	.219	5.657	9.07	.74
1/2	.84	.542	.149	9	2.639	1 703	.554	231	.323	4.547	7.046	1.09
3/4	1.05	.736	.157	8½	3.299	2.312	.866	.452	414	3.637	5.109	1.39
1	1 315	.951	182	8	4.131	2.988	1.358	71	648	2.904	4.016	2.17
1¼	1 66	1.272	.194	6½	5.215	3.996	2.164	1.271	.893	2.301	3.003	3.
1½	1.9	1.494	.203	6	5.969	4.694	2.835	1.753	1.C82	2.01	2.556	3.63
2	2.375	1.933	221	5	7.461	6.073	4.43	2.935	1.495	1.608	1.975	5.02
2½	2 875	2.315	.28	2	9.032	7.273	6.492	4.209	2.283	1.328	1.649	7.67
3	3.5	2.892	.304	1	10.996	9.085	9.621	6.985	3.052	1.091	1.328	10.25
3½	4	3.358	.321	0	12.566	10.549	12.566	8.856	3.71	.955	1.137	12.47
4	4.5	3.818	.341	0	14.137	11.995	15.904	11,449	4.455	.849	1.	14.97
4½	5.000	4.280	360	00	15.708	13.446	19.635	14.387	5.248	764	.748	18.22
5	5.563	4 813	.375	00	17.477	15 120	24.306	18.193	6.12	687	.793	20.54
6	6.625	5.75	.437	000	20.818	18.064	34.472	25.967	8 505	.577	.664	28.58

Extra strong pipe is always shipped without threads or couplings, unless otherwise specified.

Dimensions of Double Extra Strong Wrought Pipe

Diameter: Nominal Internal	Diameter: Actual External	Diameter: Approximate Internal Diameter	Thickness	Nearest Wire Gauge	Circumference: External	Circumference: Internal	Transverse Areas: External	Transverse Areas: Internal	Transverse Areas: Metal	Length of Pipe Per Sq. Foot of: External Surface	Length of Pipe Per Sq. Foot of: Internal Surface	Nominal Weight per Foot
Ins.	Inches	Inches	Inches	No.	Inches	Inches	Sq. Ins.	Sq. Ins.	Sq. Ins.	Feet	Feet	Pounds
1/2	.84	.244	.298	1	2.639	766	.554	047	.507	4.547	15.667	1.7
3/4	1.05	.422	314	1	3.299	1 326	.866	.139	.727	3.637	9.049	2.44
1	1.315	.587	.364	00	4.131	1 844	1.358	.271	1.087	2.904	6.508	3.65
1 1/4	1.66	.885	.388	00	5.215	2.78	2.164	.615	1.549	2.304	4.317	5.2
1 1/2	1 9	1.088	.406	000	5.969	3.418	2.835	93	1.905	2.01	3.511	6.4
2	2.375	1.491	.442	0000	7.461	4.684	4.43	1.744	2.686	1.608	2.561	9.02
2 1/2	2.875	1.755	.560	9/16 —	9.032	5.513	6.492	2.419	4.078	1.328	2.176	13.68
3	3.5	2.284	.608	5/8 —	10.996	7.175	9.621	4.097	5.524	1.091	1.672	18.56
3 1/2	4.	2 716	.642	5/8 ×	12.566	8.533	12.566	5.794	6.772	955	1.406	22.75
4	4.5	3.136	.682	11/16 —	14.137	9.852	15.904	7.724	8.18	.849	1.217	27.48
4 1/2	5.000	3.564	.718	3/4	15.708	11.197	19.635	9.976	9.659	.764	1.000	32.53
5	5.563	4.063	75	3/4	17.477	12.764	24.306	12.965	11.34	.687	.940	38.12
6	6.625	4.875	.875	7/8	20.813	15.315	34 472	18.666	15,806	.577	784	53.11

Double extra strong pipe is always shipped without threads or couplings unless otherwise specified.

Dimensions of Extra Strong Wrought Pipe.

Diameter: Nominal Internal	Diameter: Actual External	Diameter: Approximate Internal Diameter	Thickness	Circumference: External	Circumference: Internal	Transverse Areas: External	Transverse Areas: Internal	Transverse Areas: Metal	Length of Pipe per Sq. Foot of External Surface	Length of Pipe per Sq. Foot of Internal Surface	Length of Pipe containing one Cubic Foot	Nominal Weight per Foot	Number of Threads per Inch of Screw
Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Sq. Ins.	Sq. Ins.	Sq. Ins.	Feet	Feet	Feet	Lbs.	
1/8	.405	.27	.068	1.272	.848	.129	.0573	.0717	9.44	14.15	2513.	.241	27
1/4	.54	.364	.088	1.696	1.144	.229	.1041	.1249	7.075	10.49	1383.3	42	18
3/8	.675	.494	.091	2.121	1.552	.358	.1917	.1663	5.657	7.73	751.2	.559	18
1/2	.84	.623	.109	2.639	1.957	.554	.3048	.2492	4.547	6.13	472.4	.837	14
3/4	1.05	.824	.113	3.299	2.589	.866	.5333	.3327	3.637	4.635	270.	1.115	14
1	1.315	1.048	.134	4.131	3.292	1.358	.8626	.4954	2.904	3.645	166.9	1.668	11½
1¼	1.66	1.38	.14	5.215	4.335	2.164	1.496	.668	2.301	2.768	96.25	2.244	11½
1½	1.9	1.611	.145	5.969	5.061	2.835	2.038	.797	2.01	2.371	70.66	2.678	11½
2	2.375	2.067	.154	7.461	6.494	4.43	3.356	1.074	1.608	1.848	42.91	3.609	11½
2½	2.875	2.468	.204	9.032	7.753	6.492	4.784	1.708	1.328	1.547	30.1	5.739	8
3	3.5	3.067	.217	10.996	9.636	9.621	7.388	2.243	1.091	1.245	19.5	7.536	8
3½	4.	3.548	.226	12.566	11.146	12.566	9.887	2.679	.955	1.077	14.57	9.001	8
4	4.5	4.026	.237	14.137	12.648	15.904	12.73	3.174	.849	.949	11.31	10.665	8
4½	5.	4.508	.246	15.708	14.162	19.635	15.961	3.674	.764	.848	9.02	12.49	8
5	5.563	5.045	.259	17.477	15.849	24.306	19.99	4.316	.687	.757	7.2	14.502	8
6	6.625	6.065	.28	20.813	19.054	34.472	28.888	5.584	.577	.63	4.98	18.762	8

Brass or copper pipe would be very suitable for drainage work, but owing to the excessive cost of the two materials they are seldom used, although they may be had in standard pipe sizes and in weights that correspond to the weights of standard and extra heavy wrought-iron pipes.

EARTHENWARE PIPE.

In many localities the use of earthenware pipes for the house drain within buildings is permitted by building codes, although the consensus of opinion among sanitarians condemns earthenware pipe for this purpose. The reason that earthenware or "crock," or "tile" pipe, as it is sometimes called, is objected to, is on account of the very insecure method of joining lengths together and the liability of the joints becoming subsequently broken by a slight settlement of earth or building. On the other hand, the life of earthenware pipe buried in the earth is almost without limit, in which respect it is far superior to either cast-iron or wrought-iron pipes. However, notwithstanding the advantage of long life in favor of earthenware pipe, it is fast giving way to a more secure material, and with the exception of special cases, no doubt the use of earthenware pipe for house drains will be a practice of the past. There is no doubt, however, that there are special cases where earthenware is far superior to any other material for drainage purposes. In chemi-

cal laboratories or manufactories for chemicals which attack and destroy brass, copper or iron pipes, it is not only permissible but proper to use earthenware pipe. Of course, under such circumstances special precautions should be resorted to, to make sure the sewer will be not only tight upon completion, but that it will remain so. A good way of accomplishing this is to embed the pipes in cement concrete, thus making one continuous mono-tube of the sewer.

CAST IRON SOIL PIPE AND FITTINGS.

A length of single hub cast iron soil pipe, such as is ordinarily used in buildings, is shown in Fig. 19.

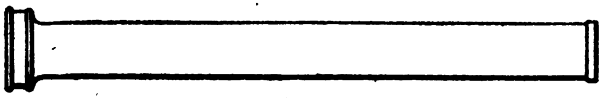


Fig. 19.

Soil pipe, of all sizes, except the 12 inch, are made in lengths of 5 feet. Twelve-inch lengths of soil pipe are made 6 feet long. When speaking of the length of soil pipe the net length, from the shoulder of the hub to the end of the pipe is understood. The hubs on cast iron soil pipe are about 2½ inches in depth, and are in addition to the 5 feet of pipe, so that a length of soil pipe over all, is 5 feet 2½ inches. Soil pipes are made in this manner so that when calked together each

length will actually measure 5 feet. One or two bands or rings are usually formed on the hub of soil pipes and fittings to reinforce the metal at this point and reduce the probability of splitting when the joints are being calked. A ring is cast on the end of all lengths of pipe and fittings to strengthen the metal at this point, and to prevent the pipes and fittings slipping too far into the hubs.

A double-hub length of soil pipe is shown in Fig. 20. Double-hub pipe is made for cutting into pieces, so that the end cut off can be used and not

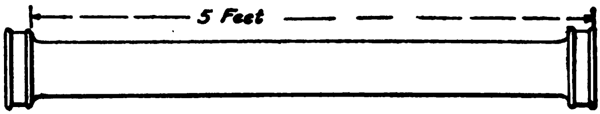


Fig. 20.

wasted, as was formerly the case before double-hub lengths of pipe were made. Double-hub pipe is made the same length over all as single-hub pipe, consequently when the length of one hub is deducted from the pipe the net length is found to be about 2½ inches shorter than the net length of single-hub pipe.

A long quarter bend is shown in Fig. 21. This fitting is used to turn a line of pipe at right angles to its original direction and is the preferred fitting when quarter bends are used. A quarter bend with side inlet is shown in Fig. 22. This fitting

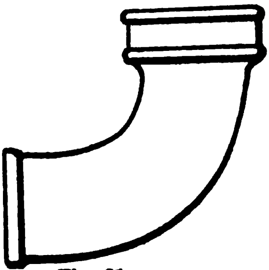
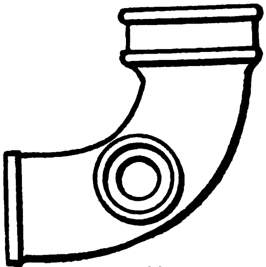


Fig. 21.



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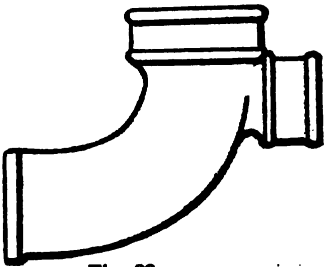


Fig. 23.

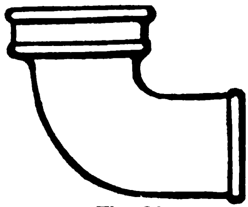


Fig. 24.

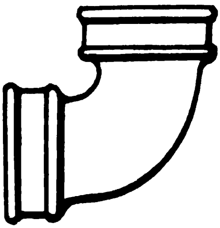


Fig. 25.

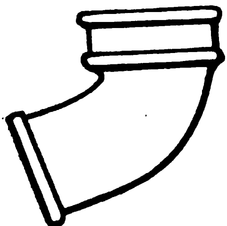


Fig. 26.

may be had with the inlet on either the right or left side. Owing to the fact that an inlet at the side of a quarter bend is objectionable, and to the further reason that the connections are T outlets, this type of fitting is not extensively used. In Fig. 23 a quarter bend with heel inlet is shown. A fitting of this kind is not so objectionable when used to discharge into a vertical pipe, but when placed at the foot of a stack, in the position shown in the illustration, some of the sewage falling down the stack would strike in the heel outlet and back up in the branch pipe.

A short quarter bend is shown in Fig. 24. Owing to the short radius of this bend it is not so desirable a fitting as the long quarter bend, and in some cities its use in the drainage system is prohibited.

A quarter bend with double hubs is shown in Fig. 25. Fittings of this description are used in order to economize material by using short pieces of pipe cut off from lengths of soil pipe. Double-hub fittings are not looked upon with favor by health boards, however, and generally their use is restricted to vent pipes. The chief objection to their use in the drainage system is that sewage flowing against the usual direction of the hub will find its way into the oakum and keep it saturated, a condition that might cause damage in an exposed position.

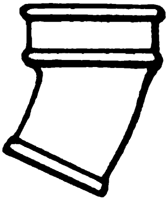


Fig. 27.

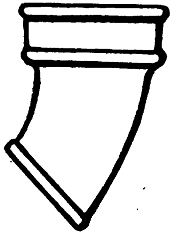


Fig. 28.

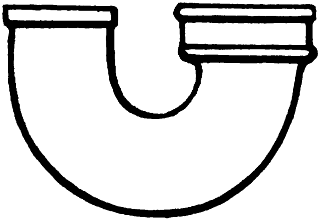


Fig. 29.

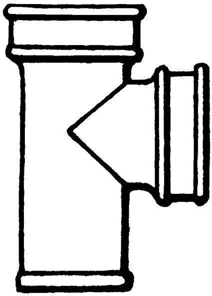


Fig. 30.

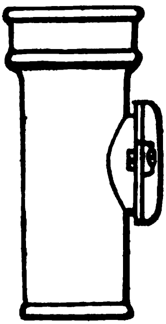


Fig. 31.

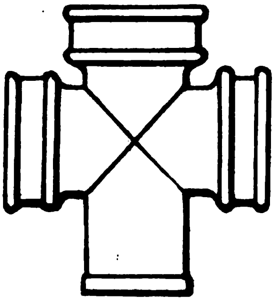


Fig. 32.

In addition to quarter bends, sixth bends, Fig. 26; sixteenth bends, Fig. 27; and eighth bends, Fig. 28, are also made. The function of these fittings is very much the same, being designed to give various degrees of angle to a line of soil pipe. Return bends, Fig. 29, are used chiefly on the ends of fresh air inlets, or in other locations to turn the outlet of a vent stack down so objects cannot easily be introduced, either through accident or design.

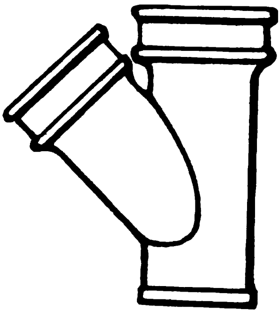


Fig. 33.

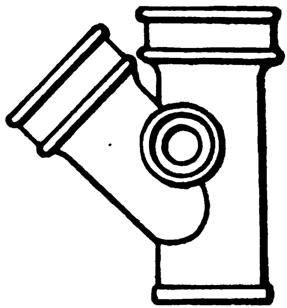


Fig. 34.

A T fitting is shown in Fig. 30. This type of fitting was once extensively used, but within recent years the use of T fittings has been restricted to vent pipes, and as a fresh air inlet connection to the house drain. The reason that T branches are objected to is due to the fact that sewage flowing into the fitting through the branch is almost brought to a standstill by being dashed against the back of

the pipe opposite the opening. A T branch with hand hole for cleanout, shown in Fig. 31, is still used to a considerable extent, notwithstanding the fact that the hand hole is made tight by means of a gasket or bed of putty. It is the consensus of opinion of sanitarians, however, that a Y fitting with a screw-thread cleanout provides a much better opening to the house drain.

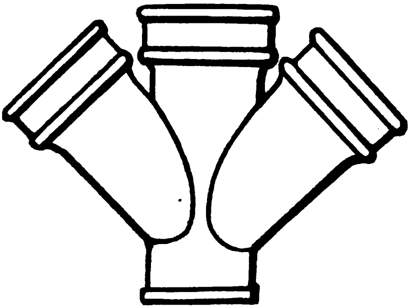


Fig. 35.

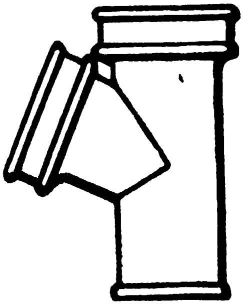


Fig. 36.

Crosshead branches (Fig. 32), like the T fittings are used now only in the ventilation system. For drainage work they are open to all of the objection of the ordinary T fittings.

Fittings to which the branch is connected at an angle of 45°, as shown in Fig. 33, are known as Y branches and are the class of fittings most suitable for branches to the house drain.

Y branches with side outlets, as shown in Fig. 34,

are used principally as water-closet connections in bath rooms and the side outlet is used for the wash basin or bathtub connection. Y fittings can be had with the inlet on either the right or left side, or with the inlets connected at an angle of 45° like the main branch.

Double Y fittings are shown in Fig. 35. This type of fitting is particularly suitable for use in

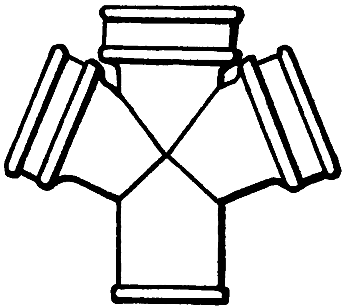


Fig. 37.

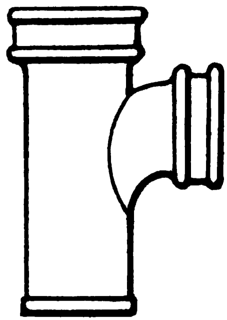


Fig. 38.

places where water closets or bath rooms are located on opposite sides of a partition. The soil pipe can then be concealed in the partition and the branch outlets will pass through the floors, at about the right distance from the walls for the closet to be connected to.

In addition to Y branches, half Y branches (Fig. 36), are also made. Half Y branches differ from Y branches only in the angle at which the branch

inlet is connected to the body of the fitting. Half Y branches are not as extensively used as are Y branches.

Double half Y branches are shown in Fig. 37. These fittings, like the double Y branch, are used when there are fixtures located on both sides of the pipe.

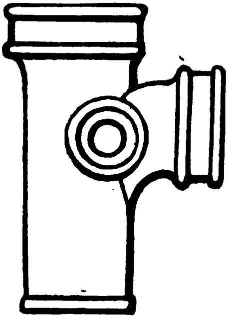


Fig. 39.

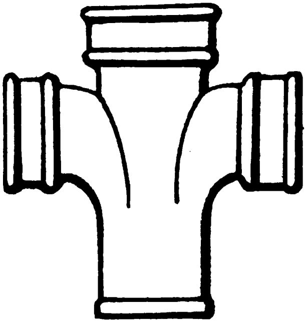


Fig. 40.

The branch fitting most commonly used as an outlet for fixtures is the TY branch, shown in Fig. 38. This fitting has the easy angles of a Y branch, while at the same time the outlet to the branch faces at right angles to the run of pipe.

A TY branch with side outlet is shown in Fig. 39. This fitting may be had with the side inlet on either the right or left side of the branch and with a T outlet, a Y outlet or a half Y outlet.

A double TY fitting is shown in Fig. 40. This type of fitting is generally used when roughing-in closets or bathrooms, on two sides of a partition.

The branches to fittings may be the same size as the run of the fittings or they may be reduced to any size smaller than the body of the fitting.

Traps are used in drainage work to prevent drain air from escaping into the building from the sewer. There are four types of traps used in drainage work, and they are known respectively as half S traps, three-quarter S traps, full S traps, and running traps. A half S trap is shown in Fig. 41. This type of trap is used near the end of a drain, and usually to trap a fixture, yard, area or rain leader. It is the simplest form of cast-iron trap made.

In Fig. 42 a half S trap is shown, with a 2-inch vent hub for back venting the trap. Half S traps are also made with inlets, either side or heel, in the dip of the trap below the seal. A half S trap, with cleanout opening, is shown in Fig. 43. This type of cleanout opening, however, depends on a gasket or putty for a seal and is not looked upon with as much favor as is a trap with a 4-inch hub, into which a 4-inch cleanout ferrule can be calked.

A three-quarter S trap is shown in Fig. 44. This type of trap is designed to calk into a Y branch or into the hub of a pipe inclined at an angle of 45 degrees from the horizontal. The trap shown in

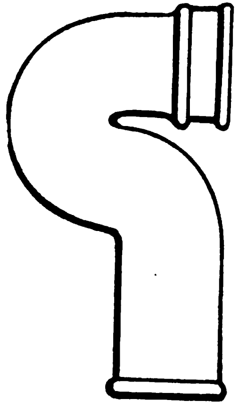


Fig. 41.

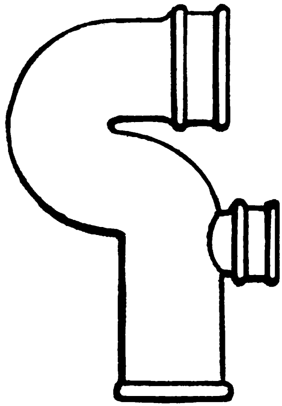


Fig. 42.

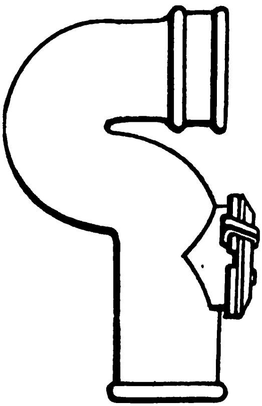


Fig. 43.

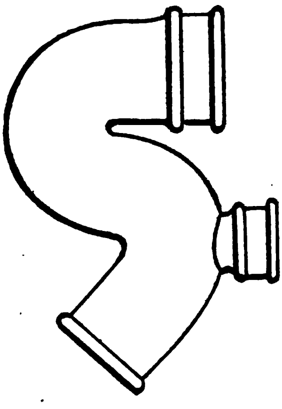


Fig. 44.

the illustration is used chiefly for trapping closets and other fixtures, and for this reason is provided with a vent opening to which a back vent pipe can be connected. Another design of the three-quarters trap is shown in Fig. 45. This trap has a cleanout cap similar to the one on the half S trap, and is open to the same objections from a sanitary standpoint.

A full S trap is shown in Fig. 46. This trap, like the half S and three-quarter S traps, is used chiefly for trapping closets and fixtures, for which reason it is provided with a vent hub. A full S trap with cleanout cap is shown in Fig. 47.

Running traps are of more interest than other types of cast-iron trap, because running traps are used for the main-drain trap in house drains. A running trap with one hub for a cleanout is shown in Fig. 48. When used as a main drain trap the cleanout opening is used for a fresh air pipe connection, and when a cleanout is desired, a Y fitting is calked into the cleanout opening, and the fresh air inlet pipe may then be connected either to the run or to the branch of the Y fitting. When this type of trap is used for a main drain trap a Y fitting should be inserted in the house drain on the sewer side of the trap, so through the cleanout in the Y a rod can be inserted to push obstructions clear through to the street sewer. The type of running trap most extensively used for the main drain trap

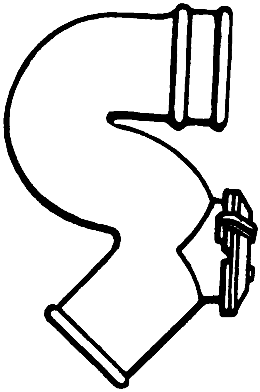


Fig. 45.

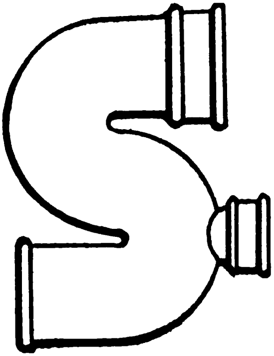


Fig. 46.

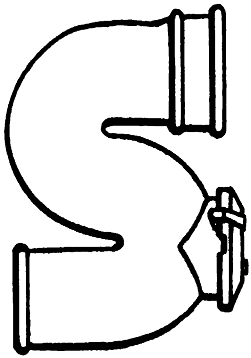


Fig. 47.

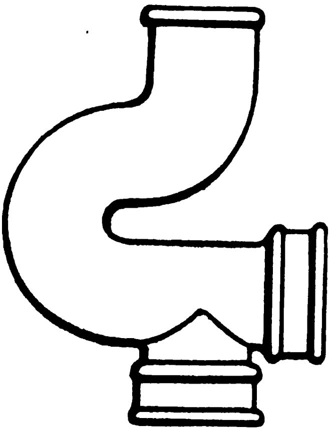


Fig. 48.

in buildings is shown in Fig. 49. This design of trap is required by the plumbing laws of most of the large cities in the country. A feature of this trap is the two hubs on the top, one of which can be used for the fresh air inlet connection, and the other for a cleanout opening.

Offsets, Fig. 50, are not extensively used in drainage systems, principally because too large a

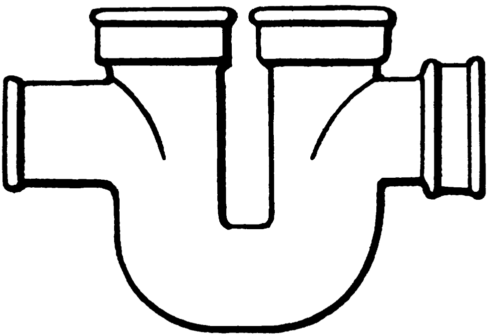


Fig. 49.

variety of offsets would have to be carried in stock, so as to meet all requirements, and it is found more convenient to make up offsets, when required, out of 1-8 bends or 1-6 bends. An offset with a 2-inch inlet is shown in Fig. 51. Such a fitting can sometimes be advantageously used when near the foot of a vent stack, where the waste from a clear water fixture, like a lavatory or bath tub, can discharge

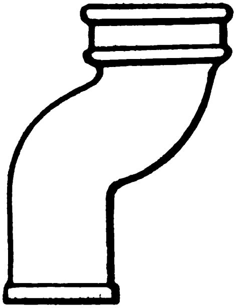


Fig. 50.

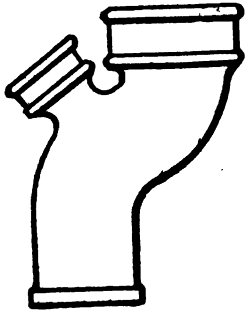


Fig. 51.

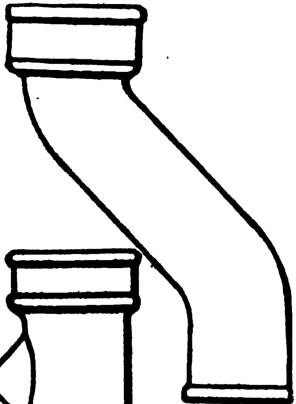


Fig. 52.

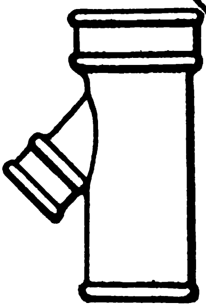


Fig. 53.

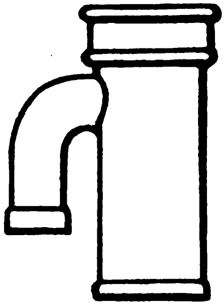


Fig. 54.

into it to wash away any deposits of dirt or rust scales that might fall down the stack. A good type of offset is shown in Fig. 52. This fitting is made with a slope of 45 degrees, and where it can be used will be found superior to an offset made up out of bends.

An inverted Y branch, Fig. 53, is used for connecting a vent stack to the main soil stack in a drainage system. Owing, however, to the greater inconvenience in connecting to this fitting than to the vent branch shown in Fig. 54, the latter type of fitting is the more generally used.

Increasers are used in cold climates to increase the size of soil, waste and vent stacks, where they pass through the roof. This increase in the size of a stack above the roof line allows for the deposit of considerable hoar frost in the pipe without completely choking the opening. An increaser is shown in Fig. 55. In most cities the plumbing laws require the fitting to be at least 9 inches in length, to allow for a gradual decrease in the size of the pipe, so no ledges will be presented on which dirt or leaves can lodge. A reducer is shown in Fig. 56. This fitting is used to calk into the hub of a pipe trap or other fitting to reduce the size of the opening. A length of smaller pipe, or a smaller fitting, can then be calked into the reducer.

Double hubs, Fig. 57, are made to calk on the ends of hubless pieces of pipe, so they can be used.

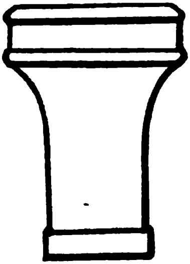


Fig. 55.

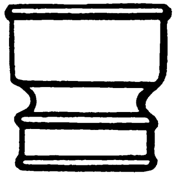


Fig. 56.

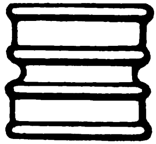


Fig. 57.

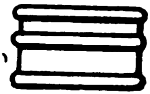
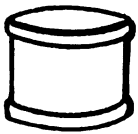


Fig. 58.



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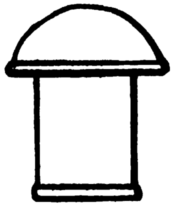

Fig. 60.

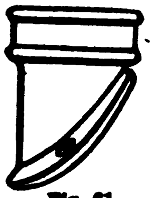

Fig. 61.

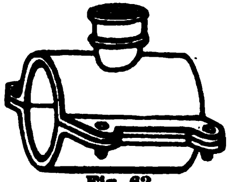

Fig. 62.

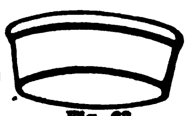

Fig. 63.

It is doubtful, however, if there is much economy attached to the use of double hubs, for by the time the hub is calked on a piece of pipe, if the time, oakum, lead and fuel required to make the joint are considered, together with the hub, it will be found that the cost will be as great as that of a new piece of pipe. A better practice is to use double-hub pipe so there will be no large pieces of hubless pipe on a job.

Single hubs are used for same purpose as double hubs, but in order to make a less bulky connection one of the hubs is made smaller than the other, thus giving more the appearance of the hub on a length of pipe. A single hub is shown in Fig. 58.

Straight sleeves, Fig. 59, are used for connecting together two pieces of pipe in place. The two pieces of pipe to be joined can be cut to a snug fit, the sleeve slipped over one piece, the pipes set in place and the sleeve moved down to cover the joint where it is calked in place.

Ventilating caps are used on fresh air inlets, when the outlet is located in an exposed place where dirt or other matter might be introduced to the pipe; also, in some localities, on the top of soil, waste and vent stacks where they extend above the roof of a building. Many cities, however, where they have plumbing laws, will not permit the use of ventilating caps on the soil, waste and vent stacks above the roof, owing to the liability of caps becoming ob-

structed with birds' nests in the summer and choked with hoar frost in the winter. A ventilating cap is shown in Fig. 60.

Saddle hubs belong to the days of poor plumbing, before plumbing codes were adopted. They are used, however, to a greater or less extent in country places where there is no one to supervise the work on repair jobs. A saddle hub is shown in Fig. 61. To use this fitting a hole must first be cut through the pipe to which the hub is to be attached and two bolt holes through which the bolts that hold the saddle hub to the pipe must be drilled. The space between the saddle hub and the pipe is then bedded in putty and the two, the pipe and saddle hub, are drawn firmly together by the bolts. Such a connection can never be depended on, and is prohibited in all cities where there are plumbing codes. The putty between the saddle hub and the pipe, when once it has dried out, is liable to crack, thus providing a channel for the escape of gas into the house, or the bolts might corrode through, thus breaking the connection at this point. There is no real economy in the use of saddle hubs and the practice of installing them should be discouraged. If, however, saddle hubs are to be used, then it is better to require a pipe band, similar to Fig. 62, which makes a much stronger and more permanent joint. Saddle hubs can be had in T patterns, Y patterns, and in half-Y patterns, and with various sizes of

outlet. In ordering saddle hubs, not only the size of outlet should be specified, but also the size of pipe the saddle is to fit, and whether the pipe is to be standard or extra heavy.

Pipe plugs, Fig. 63, are used to close the ends of pipes and the branch outlet to fittings.

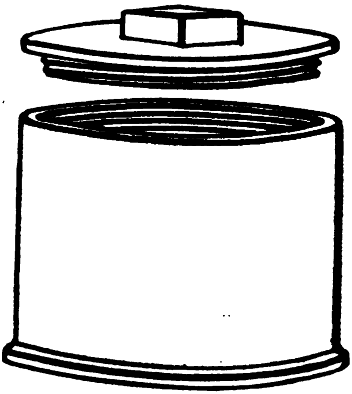

Fig. 64.

A cleanout ferrule is shown in Fig. 64. Some cleanouts have iron bodies and some have brass bodies, but the screw plug should always be of brass to prevent the plug from sticking in the ferrule. The plug shown in the illustration has a flange, so it can be screwed down only so far, and, if necessary, can be made tight by placing some lamp wick under the flange.

Some plugs, on the other hand, have no flange and depend entirely on the threads to make a tight joint. Such plugs, an illustration of which is shown in Fig. 65, are made ¼ inch thick, and the engaging parts have at least six standard iron pipe threads. The nut on top of a cleanout plug should be either

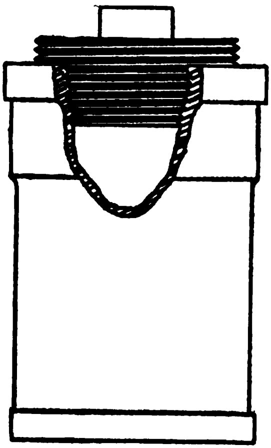

Fig. 65.

square or hexagonal, at least one-half inch high and one and one-half inches across, so that it can be firmly gripped with a wrench when taking off or putting on the plug.

Special soil, waste and vent fittings which do away with many of the joints required where stock fittings are used are now on the market. Besides

doing away with the multiplicity of joints, special fittings take up less room in a wall or partition and present on the interior a smooth, continuous surface without joints or projections. The curves and angles of these fittings are easy and in the natural direction of the flow of water and current of air.

The usual method of connecting together lengths of cast iron pipe is by means of what is known as a calked joint. Calked joints are made, as shown in Fig. 66, by fitting the spigot end of pipe or fitting into a hub, then filling the annular space between the hub and spigot with oakum and lead. The oakum is put in first and calked down hard with a hammer and calking tool. The lead is then poured in with a ladle and after the lead has cooled, it is expanded against the pipe and hub by calking with a hammer and calking tool. To calk a joint take some oakum and roll it into a rope, then with a yarning tool, and beginning at the most inaccessible point of the joint, pack in two or three strands of the oakum. When two or three strands are in place drive them solidly down in the hub by means of a calking iron and hammer. After the first layer of oakum is driven solidly home, put in a few more strands, drive it down solid, and continue that process until the hub is filled to within about 1¼ inches of the top of the hub. It is more important than is generally supposed to have the oakum well rammed in place. First, if the oakum is

properly calked it will withstand a water pressure of several pounds without leaking, and second, the oakum will hold the end of the pipe firmly in place when the lead has been poured and calked.

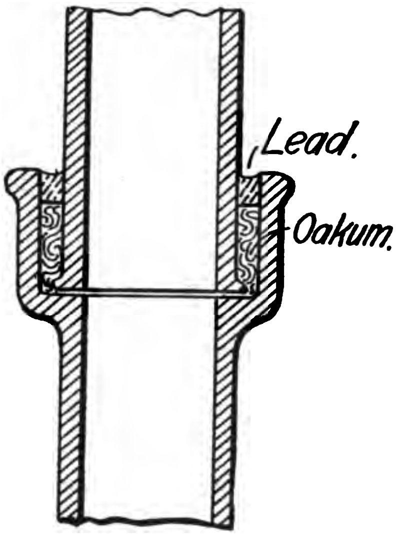

Fig. 66.

After the joint is packed with oakum the space in the hub above the oakum is filled with molten lead, allowing it to float about ¼ inch above the top of the hub. A large ladle should be used to pour the joint so the space can be filled with one pouring. If a small ladle is used the first ring of

lead sets before the second is poured, consequently there is no bond between them. When the joint is run, take a calking tool and drive the lead down in the socket, thus making it expand and fill all the crevices in the socket, so as to make an air and water tight joint, and rigidly hold the joint together.

If the oakum be carelessly packed into the joint, so that lead can run through, not only will considerable lead be lost but little ribbons of lead projecting into the pipe might cause a stoppage of the drain. If sufficient oakum is not used to fill the hub to within 1¼ inches of the top, more lead than is required to make a tight joint will be used with a corresponding increase in the cost of the work. If the hub is filled to the right level with oakum, but the oakum is not driven thoroughly home with a packing tool before the molten lead is poured into the socket, the lead will drive in too far when it is calked and an imperfect joint, liable to leak, will result.

The calking of the joints should be begun by running the calking tool around the entire joint the first time, tapping it lightly with the hammer, then around the second time, striking it with heavier blows of the hammer to drive the lead uniformly into the socket, thus avoiding unequal strains on the hub. Each blow of the hammer increases the pressure inside of the hub and care and judgment

must be exercised not to crack the hub by overcalking. Just when the lead is sufficiently packed is a matter of judgment that comes only with experience in handling iron pipe.

Joints to horizontal pipe cannot be made as easily as joints to vertical pipe. In calking a horizontal joint, the hub is packed with oakum, as in the case of an upright joint, but before lead can be run into the joint the outer edge of the socket must be closed by means of a band of clay, putty or a special asbestos joint runner. A gate or opening is left at the top of the pipe into which the molten lead is poured until the opening or gate at the top remains full of lead. It is necessary to have the lead extra hot when pouring horizontal joints, so it will not set before filling the hub. Care must be exercised when pouring a joint in a trench or in a damp place to see that no moisture is in the hub. For this reason it is well never to pack a joint and allow it to stand over night without running full of lead. Moisture is liable to collect on the oakum and when the molten lead is brought into contact with the moisture it immediately flashes into steam with an explosion which ejects the lead from the joint, scattering it in all directions. When pouring joints in a damp place it is well to place a little piece of sperm candle about the size of a pea in the joint so that the molten lead will be poured onto it. This will keep the moisture from explosively turning to

steam, and if there is too much moisture in the hub will prevent an explosion. A little powdered resin will also help to prevent a violent explosion.

To be on the side of safety, the workman should stand behind the hub when pouring a joint, so that in case of an explosion the lead will be projected away from him, not towards him.

More care should be taken when calking a cut piece of pipe into a hub than when calking in a whole length. The ring cast on the end of all lengths of pipe, and on all fittings, completely covers the base of the hub in pipe or fitting, besides, to a certain extent, centering the pipe and holding it in place in the hub. Consequently, when calking full lengths of pipe into the hub of a pipe or fitting, there is but little danger of oakum working through. With cut pipe, however, it is different, and unless oakum is calked uniformly around the pipe, there is danger of driving the oakum through into the interior of the pipe, besides forcing the pipe to one side of the hub, thus making a crooked joint.

SAND PACKED JOINTS.

Many plumbers, when they have a joint to calk in a difficult place to get at, and other plumbers on "rush" work, instead of calking the joints of soil pipe with oakum before pouring the lead, simply fill the hub about half full of sand and then pour the lead. Of course, as soon as the pipe is jarred by hammering, the sand becomes shaken

out, leaving a void where the joint should be filled with oakum well packed in place. It is needless to say that making sand packed joints is not only bad practice, but, at the same time, an expensive one, for invariably twice as much lead is used to make a joint tight as would be required if the joint were first properly packed with oakum.

LEAD REQUIRED FOR JOINTS.

The amount of lead used in calking joints depends very much, of course, on the workman. If only a little oakum is packed in a hub and the joint poured full of lead, much more metal will be used than if the hub is packed to within 1 inch or 1½ inch of the top and then poured. In estimating the cost of work no one can foretell just what kind of workmen will be on the job, or the exact amount of lead they will use, but the amount of lead that should be put in each joint is known and that amount is figured on. The amount of lead required to calk joints of different size pipe can be found in the following table.

TABLE.

Lead and Oakum Required to Calk Joints.

Size of pipe in inches	2	3	4	5	6	7	8	10	12	15
Lead required for each joint, lbs.	1½ to 2	2¼ to 3	3 to 4	3¾ to 5	4½ to 6	5¼ to 7	6 to 8	7½ to 12	9 to 12	11¼ to 15
Oakum, ounces	4	6	8	10	12	14	16	20	24	30

The smaller quantities can be estimated on for standard pipe and the larger amount for extra heavy soil pipe. A suitable allowance must also be made for lead that is lost or stolen from the job.

RUST JOINTS.

Rust joints are often required in drainage systems, where chemicals are used or where lead calked joints would not prove durable. Rust joints can be made by the following formula:

Flower of sulphur..............	1 part
Sal-ammoniac	1 part
Iron borings	98 parts

If a slow setting cement is desired, mix 198 parts of iron chips instead of 98 parts.

Another formula for a rust mixture is:

Water	18 parts
Sal-ammoniac	2 parts
Iron borings	80 parts

There are two preparations now made, known respectively as Smooth-on and as Stick-to-iron cement, either of which will make a better joint than can be made with rust mixtures and they can be made in much less time.

INSTALLING THE HOUSE DRAIN.

Location of House Drain.

THAT portion of the drainage system in a building which is run in a horizontal position, and is located in the basement or cellar, is known as the house drain. Usually the house drain extends at least five feet outside of the foundation wall where it is connected to the house sewer. The house drain is the main line of pipe which receives the discharges from all soil and waste stacks in the building. In some installations the house drain also receives rain water from rain leaders, yard, area and subsoil drains.

The location of the house drain is governed to a great extent by the depth of the cellar or height of the main sewer in the street. When the main sewer is low enough, the house drain is generally placed below the cellar floor, where it is concealed from sight and takes up no room that is valuable for other purposes. There is no reasonable objection to placing a house drain under a cellar floor, if care is taken when laying the drain, to make all joints right and properly support the lengths to prevent a possible settlement from subsequently

starting a leak. It is well, however, when burying a drain under a cement-concrete floor, to provide clean-out openings at such points that the entire inside of the house drain can be reached with a cleaning rod in case of stoppage. In many large buildings where the house drain is to be located under the cellar floor, ducts are provided to run the main drain and all of its branches in, and the top of the duct is then finished even with the floor by means of flagstones or sectional cast-iron covers which can be removed at any time from the whole length of the ducts, thus exposing the entire house drain. A pipe duct under a cellar floor cannot be considered in the nature of a necessity, and if the cost of installation is an item to be considered, the duct may well be omitted.

In many localities the main sewer is above the level of the cellar floors, and in such cases the main house drain cannot be located under the cellar floor. The chief objection to running drain pipes above the cellar floor lies in the fact that unless kept very high the several branches pass across windows and doors and cut across rooms, thus taking up valuable space, being constantly in the way and being unsightly to look at.

When necessary to run drains above the cellar floor it is well to hug the ceiling with them as closely as possible. If the cellar or basement where they are installed have high ceilings, this method

of installation will then not be so objectionable. Drains which are run above the floor must be well supported from the walls or ceiling to prevent their sagging or getting out of alignment. If the basement is to be used for business purposes, as many such basements are, greater care should be exercised in laying out the system to have all branches as much out of the way as possible and to have all lines perfectly straight and true.

Where the house drain enters a building, it is a good practice to insert a *Y* fitting with a clean-out ferrule, calked either in the branch or end, so that in case of stoppage in the house sewer, a rod can be introduced and dislodge the obstruction, pushing it through into the street sewer. A *Y* fitting is not commonly inserted in practice, and when it is not, the first fitting on the drainage system within the building is usually a main drain trap. Much difference of opinion exists among sanitarians as to the value of the main drain trap in plumbing. Those who are opposed to its use maintain that a trap is costly; stops circulation through the drainage system within the building; retards the flow of sewage and encourages deposits which might later become stoppages at this point; necessitates the use of a special fresh air inlet pipe, and blocks the only available means of ventilating the public sewers. They further claim that trapping the house drain where it enters the building cuts off the house

sewer, thus forming a dead end through which no circulation takes place.

Those who favor the retention of the main drain trap point out that the trap is used in the nature of a safety device, the same as the various traps under the different fixtures; they contend that it is better to make each plumbing installation a system complete in itself, and cut off as completely as possible from all other systems; and they maintain that it is not the duty of an individual to drain or ventilate a public utility like a street sewer through private buildings. However, most cities which have plumbing rules and regulations have passed upon the matter in so far as their city is concerned, and all that is necessary is for the plumber to follow the instructions laid down therein. In cities where the main drain trap is prohibited, all that is necessary is to continue the house drain right through the foundation wall to the house sewer, with a *Y* branch and clean-out interposed if desired, or omitted if objected to. In other cities where a main house trap is required, one of the following methods of installation may be followed, the one most suited to the purpose of course being selected.

When a main drain trap is used it becomes necessary to run in conjunction with the trap a fresh air inlet pipe. This consists of a line of pipe connected at one end to the main house drain on the house side of the main drain trap, and the other

end opening somewhere, in the yard or above the roof, to the atmosphere.

The object of a fresh air inlet is to admit fresh air from the atmosphere to circulate through the drainage system, thus keeping the air within the system comparatively pure, and to act as a relief pipe to prevent compression of air within the system when a heavy flush of water descends in a stack of soil pipe or when a strong gust of wind blows down the various soil, waste and vent stacks from above the roof. In order to fulfill the purpose for which it is installed, the fresh air inlet must be of sufficient size, and the inlet to the pipe should be so located that it will be at all times free from ice, dirt or other obstructions. A fresh air inlet is shown in connection with a portion of the house drain and house sewer, in Fig. 67. It will be noticed that the fresh air inlet is connected to a special *T* fitting, calked into the main drain trap for this purpose, while the free end of the pipe terminates in a recess in the foundation wall, which is covered for protection with the grating *a*. The frame for the grating is calked into the stonework with lead, or may be secured in place by means of sulphur. The grating proper can then be removed from the frame at any time by loosening a brass screw.

This illustration shows not only the fresh air inlet and method of connecting it to the house

drain, but also the relative positions of the clean-out *Y* and the main drain trap. The cleanout *Y* is shown with the branch and clean-out ferrule *b* turned in an upright position; this branch, however, may be turned either to the right or left so as to bring the opening in the most accessible position. Clean-out ferrules are also shown calked in the two top hubs of the main drain trap. Sometimes, however, the clean-out in the hub *c* is omitted, and a *Y* branch is calked in instead. When a *Y* fitting is used in this manner, the fresh air inlet pipe is calked into the branch, and the clean-out ferrule is calked into the end of the fitting. Connecting the fresh air inlet to the hub of a main drain trap is objectionable, however, for two different reasons. In the first place, the outlet is required for a clean-out opening, and removing the clean-out opening one fitting away makes the inside of the trap less accessible. In the second place, when a fresh air inlet is so connected, during cold weather, particularly in a severe climate, the rapid circulation of air through the house drain is liable to freeze the water in the trap, thus causing a stoppage, and perhaps bursting the trap. In very cold climates the fresh air inlet *T* is sometimes connected from five to ten feet away from the trap, to prevent any possible damage due to frost.

When a main drain trap is used in a drainage system, care should be exercised to see that the

trap is set true with regard to the water seal. Should the trap be tipped up at the inlet, so much of the water would flow from the trap that the seal would be weakened; while if the outlet be tipped up so that the inlet is lowered, sewage will be backed up in the house drain and the depth of water in the seal of the trap will be increased, thereby making more difficult the washing under of light floating matter. Furthermore, it is more difficult to make tight joints when the spigots are not entered the hubs straight.

The inlet end of a fresh air inlet pipe should be so placed that when discharging foul air, as will occasionally happen, the odors cannot be carried into the building through windows, doors or other openings, or in other ways be disagreeable to the public or to inmates of the building. To prevent such a nuisance the inlet should not be within fifteen feet of any window, door, furnace air inlet, fireplace flue, air shaft, or other opening communicating with the interior of a building.

It is customary not to run a fresh air inlet in a horizontal position, but, when possible, to give it a pitch of 45 degrees from the horizontal to insure any dirt or refuse entering the pipe rolling or sliding down to the drain, from where it can be washed out. If impossible to give the fresh air inlet a grade of 45 degrees, it should be given as much pitch as the circumstances will allow.

In some cities the plumbing laws require the inlet to the fresh air pipe to be located at the curb in the street. When a curb fresh air inlet is used, a brick basin about twelve inches square and eighteen inches deep is built, with twelve-inch walls at the curb, and the fresh air inlet pipe enters the side of this basin or box about four inches from the bottom. The four inches beneath the level of the fresh air inlet is to allow space for the accumulation of dirt and sweepings, which will gradually fill up the box. Over the top of the curb box a flagstone is laid, after first cutting a hole through the stone and leading in a fresh air inlet grate, similar to that shown at *a* in Fig. 67. Sometimes when the curb is high enough the fresh air inlet grate is fastened to the curb at the side. Such a location reduces the amount of dirt that will find its way into the box, but it makes it more inconvenient for cleaning out the dirt. It should be remembered that in any form of fresh air inlet grate the area of the perforations or slots should at least equal and preferably should be greater than the area of the fresh air inlet pipe.

When a cement sidewalk is laid in front of a building, the cement concrete is continued over the top of the box and the fresh air inlet grate is securely set in the concrete, flush with the surface. The suggestion has been made in a work on plumbing to extend the fresh air inlet pipe flush with

the sidewalk at the curb, and cover the inlet with a perforated hollow stepping block. The same work also shows a hollow iron hitching post connected to a fresh air inlet. From a sanitary standpoint neither of these inlets is an improvement over the ordinary curb box inlet, but, on the contrary, they are open to the objections that they are more expensive and would prove an obstruction to the sidewalk, particularly in crowded streets. For these reasons they are never used.

It is sometimes possible to use a fresh air inlet for a rain leader pipe, and while there are very few cities having a plumbing code where such practice would be permitted, if the roof that is to be drained, or the inlet from the gutter to the rain leader is a sufficient distance from all openings to the building so that a trap would not be required on the rain leader, there is no good reason why such a practice would not be acceptable. Of course, in the event of using a fresh air inlet pipe for a rain leader, the connection to the main drain should be made with a Y fitting, instead of a T, the same as for all other rain leaders, soil or waste branches. If connection were made with a T branch, during heavy storms, the rain water entering the main drain, across the direction of flow might completely check the flow of sewage from the soil and waste lines unless other rain leaders were connected to the main drain further back in the system.

The fresh air inlet from detached houses, particularly where there is a large area of ground around the houses, can be run to a convenient clump of bushes, not less than 20 feet from the building, and terminated there by caulking into the pipe where it extends above the ground, a return bend so that the opening will face the ground. It is customary to extend the bend about 18 inches above the ground and it is well to protect the inlet with a wire netting to keep out birds and at the same time prevent children from mischievously filling the pipe with sticks, grass and soil. The object of putting it in a cluster of bushes is to be out of the way and not in a position where it will attract children's attention. In some localities the fresh air inlet is extended to above the roof of the buildings the same as the soil waste and vent stacks. This method would hardly be satisfactory in extremely tall buildings but for cottage work seems to be very satisfactory. When the inlet is located above the roof there is no danger of stoppage from dirt or snow—if dirt, leaves or snow or other material, enter the pipe they will fall by the force of gravity to the drain below. Further, when located above the roof the inlet is away from all openings to the building and from the public thoroughfares, consequently it cannot become disagreeable to the inmates or a nuisance to the public. And last, but not least this method for small buildings, is not more costly than

any other method when cost of excavating, mason work, etc., is considered. Some authorities object to extending the fresh air inlet above the roof, on the grounds that the various stacks in the building will be of so nearly the same height that there will be no circulation of air through the drainage system. That is hardly true, however, for local conditions are bound to create different temperatures in the various stacks, and currents or circulation of air will follow, even though it is not down through the fresh air inlet and out through the soil and waste stacks. As a matter of fact, however, the circulation of air should be in that very direction. Discharges of hot water into the soil and waste lines should so raise the temperature of the air within that an up draft of air would be assured. Further, a watery vapor is lighter than dry air and the vapor in soil and waste pipes would aid circulation in the right direction.

Anti-blow-back valves have been suggested as a means of preventing the disagreeable feature of foul air being puffed from the mouth of a fresh air inlet pipe. Anti-blow-back valves are lightly poised check valves which stand open under normal conditions but close the opening to the fresh air inlet when there is a down draft in the drainage system, due to the wind blowing into the stacks above the roof or to a heavy flush of water in one of the soil stacks, within the building. It has even been suggested to

locate these valves in the cellar or basement where the trap is placed, and depend on the quick closing of the valve to prevent the escape of foul air into the building. Anti-blow-back valves were not very favorably received by the trade and their use was rather limited. When permitted it would seem the part of wisdom to prohibit their use inside of a building, and require that they be located at a point, well away from windows, doors, and other openings to dwellings.

Automatic flushing devices are made for flushing with water the interior of fresh air inlets, thus keeping them free from deposits of dirt. If a fresh air inlet is properly constructed, however, there will be no necessity for periodical flushing, and the additional and unnecessary cost of installing a flushing device can be dispensed with. If a fresh air inlet cannot be put in without necessitating a whole lot of additional apparatus, costly to install and expensive to maintain, to keep the fresh air inlet in order, it would be far better practice to omit entirely the main drain trap and fresh air inlet, thereby simplifying the installation and cheapening the cost.

Fresh air inlets should be proportioned in size to the size of the main drain pipe. They should be the full size of the house drain for all sizes of drains up to 4 inches in diameter, and for 5-inch and 6-inch drains, should not be less than 4 inches in diameter.

For drains 7 inches and 8 inches in diameter the fresh air inlet should be not less than 6 inches in diameter, and for larger drains, not less than 8 inches in diameter.

CONNECTIONS TO HOUSE DRAINS.

Branch connections to house drains should be made with special fitting which connect to the main at such an angle that the inflowing sewage will mingle with the sewage in the main without impeding or checking its flow. It is not only necessary to use the right type of fitting for a branch connection but the fitting must also be properly installed, for if a Y branch were used, but connected so that inflowing sewage would run up grade in the main drain, the connection would be worse than if a T branch were used. The use of T branches is generally prohibited in cities having plumbing laws, although to a limited extent they are used in cities where there are no rules and regulations. T fittings are objectionable because when used on a horizontal drain, either to take out a horizontal or a vertical branch, sewage flowing into the main from the branch has its column divided so that part of the liquid flows toward the natural outlet while the remainder back up in the drain, until after the entire discharge has flowed from the branch, when that portion which has been backed up in the main, may drain away. The action of water or sewage flowing

into a drain from a T branch is shown in Fig. 68. This illustration shows the theoretical manner in which the water would be divided and flow in both directions if the horizontal drain were perfectly level; but, as a matter of fact, the drain pipe has more or less of a fall toward its natural outlet at the main drain trap, so that in actual use in a plumbing installation, there would be less than half that would flow up grade. Furthermore, the steeper the grade, at which the house drain was laid, the more sewage would flow in the right direction, toward the outlet.

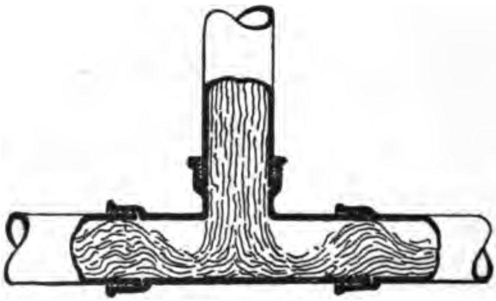

Fig. 68.

let. If, however, vertical branches are to be taken from a house drain, the drain cannot have a very steep fall, without throwing the vertical stacks out of plum.

Branch T fittings are not so objectionable in vertical stacks of soil and waste pipe, because the sewage cannot flow up in the pipe. If the volume of

water flowing from a branch pipe into a vertical stack is a large one, however, it will interfere more or less with the sewage descending the vertical stack, and, even when no sewage is flowing down the main stack, the sewage flowing into it from the

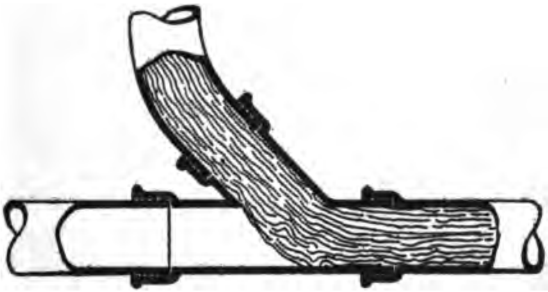

Fig. 69.

branch, has its velocity checked by dashing against the back of the vertical stack. For these reasons T fittings are objectionable, on vertical stacks as well as on horizontal drains and should not be used for branch connections to any pipe through which soil or waste water flows, although they may be used for branch connections to the ventilating system. There is nothing gained by the use of T fittings, in the drainage system for the fittings cost as much as more improved fittings, and take, if anything, longer to install; for the branch to the fitting is so close to the top of the hub into which it must

be calked that more time is required to make this joint tight.

When sewage from the branch of a Y fitting flows into the main drain, both the streams are flowing in the same general direction and the fluids mix and flow harmoniously together; the sewage from the branch by its greater velocity if from a vertical stack, or by increasing the volume in any event, adding both to the scouring effect and velocity of flow in the main drain pipe. Scouring velocities are what should be aimed at in all drainage systems, so that each flush of water through a drain will help to scour the sides and carry all matter along to the main street sewer, thus leaving the pipes within comparatively clean and free from objectionable organic matter.

The flow of water from a Y branch connection into the main drain is shown in Fig. 69. As can be seen by the illustration there is no backing up in the drain with this form of connection, and the steeper the grade of the main drain, of course the less tendency there would be to back up in the horizontal pipe. A Y branch with a ⅛ bend calked into it so as to turn the branch at right angles from the stack, makes a splendid connection between a horizontal soil or waste pipe and a vertical stack of soil of waste pipe. It would also make a good connection or outlet for a water closet or other fixture in toilet or bath room, if it were not for the room

required for such a connection. From the back of the soil pipe to the face of the 1/8 bend, varies from 18 inches to 22 inches, according to the make of fitting used, and that distance would extend the fixture openings so far into the rooms, that a Y and 1/8 bend can seldom be used. It was for the object of combining a right angle opening with the easy waterway of a Y branch that the T Y fitting was designed. There are two types of T Y fittings. The short pattern is little more than a T fitting with the branch curved a little toward the fitting outlet. The curvature given the branch of such fittings, while little, is sufficient for the purpose when the fittings are used only for fixture connections and are used only on vertical stacks of soil and waste pipe. They are no more suitable than T fittings, however, for vertical branch connections to horizontal drains. What are known as long turn or longsweep T Y fittings are a combination of a Y fitting and 1/8 bend, all in one fitting. Long turn T Y fittings when properly designed, are in every way as satisfactory as Y fittings and 1/8 bends, for making branch connections to horizontal drains. All fittings, however, which are called long turn do not properly come under that classification, and unless the outer curve, Fig. 70, covers the full bore of the branch outlet, the fitting cannot be considered suitable for use in a horizontal drain. The illustration shows, not what is the best type of long turn T Y or

Sanitary T, as it is sometimes called, but the least radius of curvature, that is acceptable for use in horizontal drains. Many patterns of T Y fittings have a larger radius and are far superior to the one shown in the illustration. It will be seen by referring to the illustration that the flow of sewage from the branch into the main is quite similar to the flow from the branch of a Y fitting, and does not

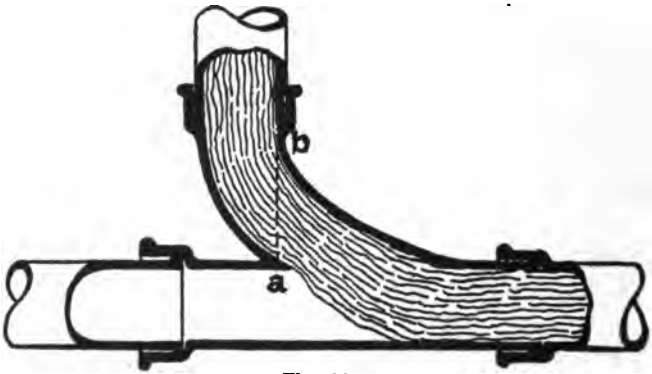

Fig. 70.

back up in the drain as does water or sewage from the branch of a T fitting.

When a horizontal branch is taken off from a horizontal drain pipe, great care must be exercised to see that the branch of the fitting is given a slight grade so sewage cannot back up in it. Many workmen are rather careless in this respect and the result is that frequently the joints of branch connec-

tions have to be cramped to give a fall to the branch drain.

In Fig. 71 are shown various ways in which the branch outlet from a Y fitting can be run. If the branch is to be extended at an angle of 45° from the main drain, a length of pipe *b,* would be calked into the hub of the branch. That is the usual method of connecting a branch drain to the main drain in the

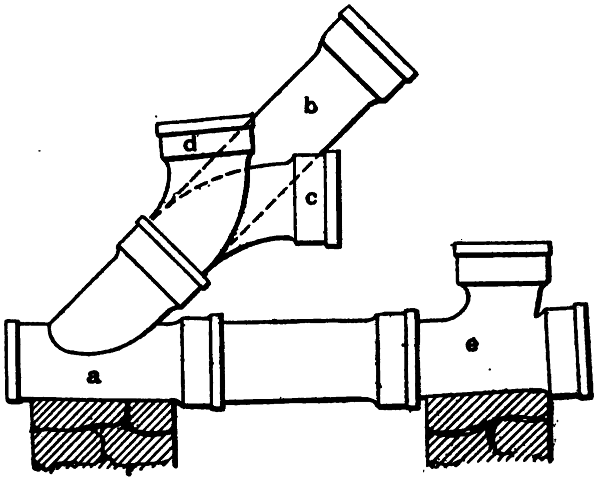

Fig. 71.

drainage system. If for any reason, however, it is necessary to continue the branch drain parallel with the main drain, it can be turned in that direction, as shown, by means of the ⅛ bend *C.* The

bend *C*, need not be calked into the hub of the branch to the Y fitting but, if greater distance is required between the parallel lines of pipe the 1/8 bend can be calked into the end of a piece of pipe of the right length, and this pipe can be calked into the branch of the Y fitting. If, on the other hand, it is desired to run the branch from the Y fitting at right angles to the main drain, the pipe can be turned in that direction by means of the 1/8 bend, *d*, and this fitting may be used at any distance from the main drain to turn the branch at right angles, the same as was explained for turning the branch parallel with the main drain. If the branch is to be run at different angles than those shown in the illustration, the right direction for the pipe can be given by using a fitting of the right degree, or by using two or more fittings of the right angles. For instance, a 1/4 bend or two 1/8 bends would turn the branch from the Y at right angles to its normal direction; a 1/6 bend would give the line a direction between a 1/4 and a 1/8 bend; a 1/8 bend and a 1/16 bend would give the pipe a turn part way between a 1/6 bend and a 1/4 bend, while a 1/16 bend would give the pipe a turn between a 1/8 bend and a straight length of pipe. And so it goes; by using two or more fittings in various combinations, any desired degree of branch can be had. In this illustration, a Y branch fitting with some of its various combinations is shown contrasted

with a short T Y fitting. The short curve to the branch, between its hub and where it joins the body of the fitting will be noticed and it will be observed that sewage falling into this fitting from a vertical stack would be backed up in the main drain almost to as great an extent as if an ordinary T fitting were used. By turning the illustration on its side, however, it will be seen that the short curve, little as it is, would be sufficient in a fitting for a water closet or other fixture discharging into a vertical stack.

CONNECTING STACKS TO END OF DRAINS.

Connections to house drains are often made at the end of a run of pipe. In such cases, the connection is usually a vertical stack of soil or waste pipe, or in some cases a rain leader. There are two methods of connecting to the house drain under such conditions and the method of connecting will depend somewhat on the location of the house drain, and whether it is above or below ground. If the vertical connection is for a rain leader, or for a stack from a fixture or group of fixtures using only clear water, without soil or grease, the end of the drain may be turned up to receive the vertical stack. In this case, however, the turn should be made by means of two 1/8 bends, or by means of a long turn or sweep, 1/4-bend, having a radius of at least 4 diameters of the fittings.

Of course, the bottom of the stack will have to be supported to take the strain due to its weight off of the hangers or supports along the line of vertical pipe, and a brick or concrete pier forms a good base for the stack to rest upon. When a long turn ¼-bend is used at the bottom of a stock of soil, waste or rain leader pipe, it is well to use a bend with a "duck foot" so as to project the weight

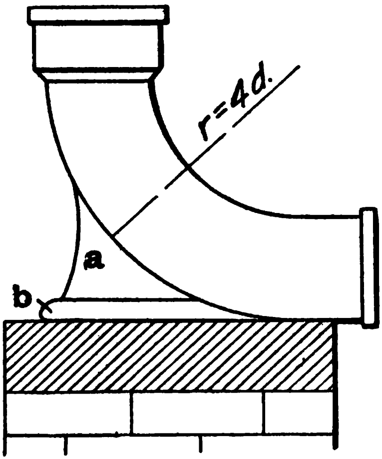

Fig. 72.

directly down onto the pier without exposing the bend itself to a cross-strain. A long turn ¼-bend with a "duck foot" rest is shown in Fig. 72. The duck foot consists simply of a thin fin of cast-iron, *a*, which transmits the weight of the stack to the

broad cast-iron base, *b*, which in turn rests on a suitable base or foundation to support the stack. The bend shown in the illustration has a radius of four times the diameter of the pipe; by that is meant that the distance from the centre of a circle described by the radius, to the arc of the circle, is

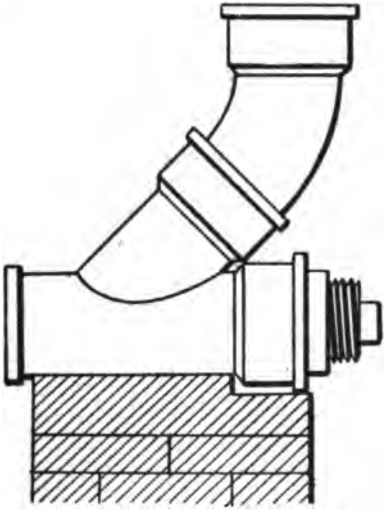

Fig. 73.

just four times the inside diameter of the pipe. For instance, if the bend shown in the illustration has a four-inch inside diameter, the radius, *r*, would equal $4 \times 4 = 16$ inches. While a bend of this character is quite suitable for the foot of stacks from

clear water fixtures, it may also be used at the foot of stacks from soil fixtures, where the house drain is buried in the ground. It may also be said that a ¼-bend of long radius may be used when necessary in a horizontal position, the curve of the bend offering so little resistance to the flow of sewage that it may be considered as of but little more friction to overcome than would be presented in an equal length of straight pipe of the same size and material.

A good method of connecting the foot of a stack of soil or waste pipe to the house drain, when the house drain is in an exposed and accessible position, is shown in Fig. 73. With this method a branch connection for the vertical stack is taken off the same as for an ordinary connection, as previously described, and the end of the Y fitting is closed with a clean-out ferrule. This makes an ideal connection. There is not much, in fact, there is no, danger of the vertical stack of pipe becoming obstructed. Anything which enters the pipe will fall to the horizontal drain below, or will be carried down by the weight of water falling on it from above; and if such obstructions cause a stoppage after reaching the house drain, they can be removed through the clean-out opening at the foot of the stack, or if too far away to be removed, they can be forced through by means of a rod introduced through this clean-out opening.

In some respects this form of connection is not so good as a long sweep ¼-bend with duck's foot rest. The strain due to the weight of the stack is not transmitted direct to the pier below in this case, but is slightly to one side, thus imposing considerable stress on the ⅛-bend and the branch of the fitting. This connection is further objected to by some authorities on account of the short dead end which forms a fouling place, to retain any organic matter splashed onto it from the descending column of liquid in the vertical stack. The amount of matter retained in this dead end, however, is so slight that it would seem the good features of this form of connection more than offset the objections.

LOCATION OF CLEAN-OUT FERRULES.

In a well designed drainage system, clean-outs should be located at such points that access can be had to all parts within the drain, that are liable to stoppage, without cutting up floors or walls, or breaking or tapping the pipe. Clean-outs are not required in the vertical stacks of soil, waste and leader pipes, but are necessary only in horizontal runs of pipe, whether suspended from the ceiling or buried in the earth. Usually each trap within the building has one or two clean-out ferrules calked into the vent hubs. A clean-out is commonly calked into either the run or the branch of a

Y-fitting at the front foundation wall of the building, where the main drain enters the cellar, so that a rod can be shoved clear through to the street sewer. At various points along the main drain and its branches, it is a good practice to insert Y-fittings with clean-out ferrules, calked into the branches, so that a rod can reach from one clean-out ferrule to another, thus making accessible every part of the interior of the drainage system. In horizontal waste pipe from kitchen, scullery or other sinks into which large quantities of grease are liable to be discharged, clean-out ferrules should be provided about every ten feet along the horizontal runs through which to remove the grease which often adheres to the sides of the pipes until it completely chokes the bore of the pipe, thus causing a stoppage of the drain.

In buildings where the soil pipe or the main drain is buried in the earth beneath the cellar floor, it is a good practice to extend the clean-out openings from the traps to the level of the floor and there calk in the clean-out ferrules. If the drain is not at too great depth below the floor, the clean-out openings along the lines of drains may also be extended to the surface of the floor. However, if the drains are at such depths that extending the branch clean-out openings to the surface of the floor would make cleaning of the pipe more difficult, it might be better practice to calk the clean-out ferrules into the

branch of the Y-fittings, and provide pits to make the clean-outs accessible. In that case the tops of the pits would be covered with removable flagstones, or iron covers.

The size of clean-out openings is of as much importance as their location. It stands to reason that little is gained by arranging a good system of clean-outs, but installing clean-out ferrules of such small sizes that they are of little use for the purpose for which they were installed. It may be stated that, as a rule, clean-out ferrules should be the full size of the main pipe to which they are connected from 2 inches to 5 inches in diameter. A five-inch clean-out ferrule, however, is about the largest that will ever be required, and this size may safely be calked into any size house drain that is liable to be installed in any building.

Iron-body clean-out ferrules with brass plugs are better as a rule than brass clean-out ferrules. Iron-body ferrules are made heavier and are, therefore, more rigid and easier to make tight than are brass clean-out ferrules. Brass clean-out ferrules, on the other hand, are made quite thin, so that the metal gives under the process of calking, thereby making it difficult to calk a tight joint. When calking brass ferrules into the hubs of pipes or fittings, the plug should be screwed into the ferrule to prevent it being so bent out of shape that the plug cannot be entered and screwed down to make a gas and

water-tight joint. Before the plug for a clean-out ferrule is screwed into place, the threads should be well lubricated with graphite or some other good material, which will prevent the plug from sticking to the threads of the ferrule. If at any time the plug is subsequently removed from a ferrule to clean out the drain, before replacing the plug it should be again lubricated as when originally made up.

SUPPORTS FOR HOUSE DRAINS.

It is of the utmost importance that the entire house drainage system be supported throughout its entire length to prevent unequal settlement of the mains and branches. If care is not taken in this respect, parts of the drain, by settling, will form traps which will remain full of sewage. The presence of a pipe line full of sewage is objectionable, not only on account of the purification which takes place within the drain and the retention of sewage which should be discharged in as fresh condition as possible at the sewage outfall, but for the further reasons that such accumulation of liquid completely stops circulation of air through the pipe, and consequent ventilation of the system, besides interposing a mass which seriously interferes with the flow of sewage with a cleansing velocity. Such pools of sewage also tend to a deposition of solid matter, and a possible stoppage of the drain.

When drains are run in the earth, beneath the basement or cellar floor, it is a good practice to grade the bottom of the trench at the right pitch or fall, and lay the lengths of pipe on the undisturbed earth, after first scooping out the earth where the hubs come, and a sufficient length in front of the hubs to allow for calking the joints. Unfortunately, however, trenches are usually dug by laborers, without any regard to the depth of trench, or grade of the bottom so that when the workman is ready to install the pipe, he must accept conditions as he finds them and overcome whatever difficulties are presented. Usually a trench is dug too deep, and in order to gain a good, firm bearing for the house drain it is necessary to build up piers of loose brick from the bottom of the trench to the underside of the pipe. If the trench bottom is not too far beneath the bottom of the pipe, one tier of bricks laid flat will provide a sufficient support for the pipes, for after the trench is filled and the earth compacted into place the pipe will have a firm bearing along its entire length. When placing the brick supports under the pipes of a house drain they should be placed immediately under or just back of the hubs, and in work that is to be covered with earth it is well to place a support at the hub of each length of pipe as well as under every branch connection. If the depth at which the pipe is buried in the earth is any considerable distance, the pipe

will require all of these rests to support the weight of earth imposed upon it. Supports can be spaced at greater distance when the drain is run above the cellar or basement floor, as there is less weight to support and the pipe is exposed to view, so that any settlement in the line can be noticed immediately. When house drains are run above the cellar or basement floor, but not at any great height, brick piers are commonly used for their support. Brick piers to support drain pipes should be 8 inches or 12 inches square, according to the height they are to be carried. They should be laid up in cement mortar and capped with a flagstone to distribute the pressure over the entire surface of the pier, and at the same time serve as a binder to hold the top course of bricks together. Instead of a flagstone cap, a cap of Portland cement concrete will prove equally satisfactory for this purpose. When brick piers are run alongside of brick walls, smaller piers can be used, by bonding the brickwork of the piers with that of the wall. This will give the piers such stability that they will only be required of sufficient size to sustain the weight of the pipe and contents. Brick piers for the support of house drains need be spaced only about every ten feet apart. A pier, however, should be placed under the branch fitting to every vertical stack, and when the distance between stacks is not over 25 feet, one pier in between should prove sufficient for the purpose.

Instead of brick piers, pipe rests are now being extensively used to support the house drain, and as a bearing for the fitting at the foot of a stack. Pipe rests consist of a saddle of the right radius of curvature for the pipe it is to support, a flange to rest on the floor and a short piece of pipe between the saddle and the flange. The saddle and

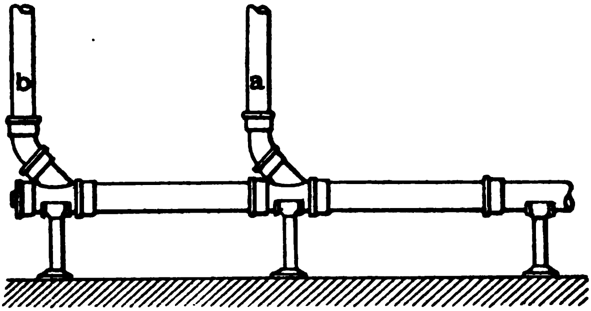

Fig. 74.

floor flange are threaded or tapped so that short pieces of iron pipe can be used for the standard and can be cut any length to give the required fall to the drain. An illustration showing pipe standards used in connection with a horizontal drain may be seen in Fig. 74. This illustration shows not only the method of supporting a house drain with pipe rests, but also the usual methods, *a*, of connecting the branch from a vertical stack from the main drain, and the manner, *b*, of connecting the

end of a drain to a vertical stack, with a clean-out ferrule in the end of the drain fitting. The use of pipe-hooks is generally condemned for supporting house drains, stacks, and branches. If, however, the hooks are of heavy pattern and are properly used, there are conditions under which they are permissible. It might be stated as a general rule, applicable to all cases, that hooks should not be used to support pipes from brick, stone or concrete walls or partitions. Hooks lack sufficient holding power in any of those materials to insure their permanency, and even when the wall is first plugged with wood, the hooks are liable to become jarred loose at some subsequent time, or the wooden plugs might shrink to such an extent that the hooks will be loose. When, however, cast-iron soil pipe or drain pipe is run alongside of a wooden partition, or when stacks of soil and waste pipe are run in frame buildings, and pass close to joists so that a couple of good hooks can be driven into the woodwork close under the hubs of the pipe, this method of securing pipe is not objectionable in low buildings, and particularly if the soil pipe is of standard weight. Many drainage systems have been installed in low frame buildings, and hooks used for the only support, with the result that complete satisfaction has been attained, without any subsequent settlement of the drainage system. When pipe hooks are used to support a house drain, the planks

should be long and the driving shoulder of the hook should not be driven in past the center axis of the pipe or the support will be weakened.

In some buildings where the house drain will be run at too high an elevation to conveniently use brick piers or pipe rests, stone corbels have been built into the brickwork to support the pipe. When corbels are used they are set in place long before the pipe is installed and great care must be exercised to get them in their right places so the drain will have a proper fall in the right direction. Stone corbels are rather objectionable for pipe rests for two reasons. As generally made and installed the corbels are level on top, so that when the house drain is laid in place, the pipe rests only on one edge of the corbels, instead of bearing along the entire upper surfaces. In the second place, there is nothing to keep the pipe from being worked off the corbels between stacks spaced great distances apart, and pipe hooks have to be used to hold them in place.

Of course, the corbels could be made so as to overcome both of these objections, but the cost would be too great. As it is, a better support at far less cost can be had by using a pipe bracket attached to the wall by means of expansion bolts. A bracket for iron pipe is shown attached to a wall by means of an expansion bolt in Fig. 75. To attach these brackets the location is first ascertained,

a hole of the right size is then drilled for the expansion bolt, the expansion nut slipped into the hole, and the bolt screwed in tight. The tighter the bolt is screwed into the expansion nut the more

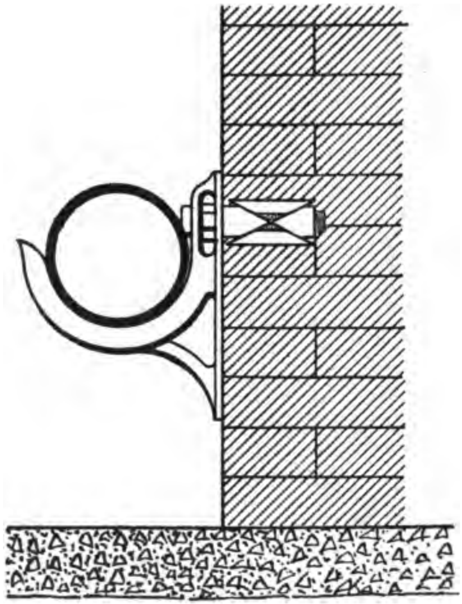

Fig. 75.

the nut expands against the side of the hole, and consequently the tighter will it hold the bracket to the wall. Expansion bolts are successfully used, also, for fastening the ends of pipe bands which are

strapped around pipes under the hubs to support a line in place.

Pipe supports, of the hanger variety, are often used for securing pipes to side walls. One type of pipe support used for this purpose, and the method of connecting it to a side wall, is shown in Fig. 76. This is what is called a split-ring hanger. By taking out the two bolts, *a, a,* the upper half of the

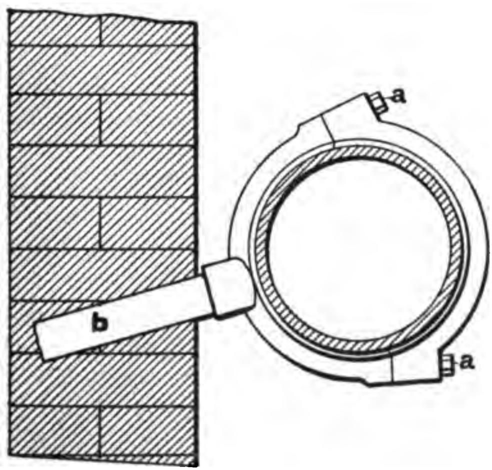

Fig. 76.

ring can be removed and replaced when the drain is resting on the other half of the circle. To attach this hanger to a wall, a hole the size of the shank, *b*, is first drilled in the brick work with a

slight downward pitch so the tendency under a load will not be to slide out, and the shank is then driven into the snug-fitting hole. The shank, *b,* of this type of hanger, is made of wrought pipe, and the socket is tapped with a standard iron pipe thread. The size of pipe is graduated to the size of the hanger so that the heavier the pipe to be supported the stronger the shank to support the weight.

The horizontal drains in a building cannot always be run alongside of walls or partitions, and it would make an awkward installation to support from the floor pipes, which cut across a room, not to mention the valuable space taken up by pipes, piers and supports. For these reasons when a main drain or any of its branches, must pass through a room or corridor the pipe is usually suspended from the ceiling and is run as close to the ceiling as is convenient or possible. When pipes are run under a ceiling they are supported by pipe hangers attached to the floor beams above. A pipe hanger used for this purpose is shown in Fig. 77. The upper part of the hanger is provided with a good screw, *a,* so that it can be screwed into wood joists or beams. That part of the hanger which clamps around the pipe is made in two sections, so it can be put in place after the pipe is installed. It is customary for the workman when installing pipe in place beneath a ceiling to make temporary hangers of wood to hold the pipe until such time as he is

ready to put on the permanent hangers. He then lines up the pipe, gets it as nearly level as possible

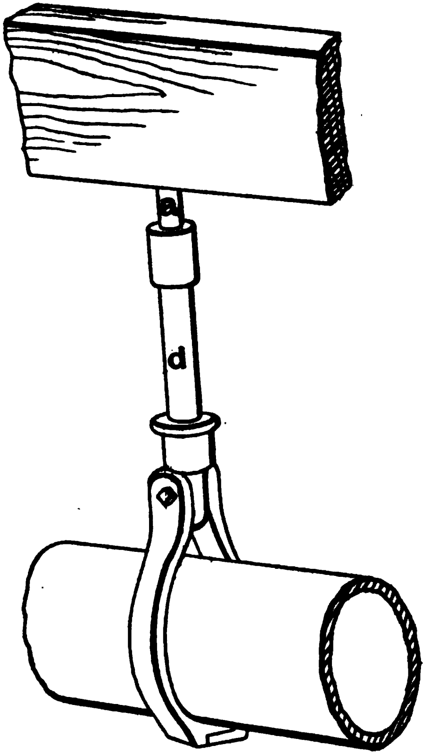

Fig. 77.

and free from side curves, after which he supports it permanently and then applies his tests. It is

necessary to have the permanent hangers in place before testing a drainage system, because some of the joints might be sprung aleak by working on the pipe putting on the permanent hangers. The section, *b*, of the hanger is made of ⅜-inch or ½-inch wrought pipe, which may be cut any length to adjust the hanger to the distance from the beams. This hanger is what is known to the trade as an adjustable hanger, not only because it can be adjusted to a pipe after it is in place, but also because it will give or swing like a sling in case the pipe expands and thus creeps along. This feature of the hanger is not of so much importance when supporting drain pipes, which expand but slightly, as it is when supporting steam or hot water pipes which sometimes expand as much as 1½ inches in 100 feet of length of pipe.

In buildings of fireproof construction where the beams are of iron or steel a different method must be employed for securing the pipe hangers to the beams. This is usually done by means of an iron clamp which is fastened to the under flange of the I beams. A pipe hanger attached to an iron beam is shown in Fig. 78. This hanger is similar to the one shown in Fig. 77, from which it differs only in having a clamp, *a*, to take the place of the screw thread. Hangers are usually spaced about ten feet apart on horizontal drains, but, additional hangers are usually employed on both sides

of a branch fitting for a vertical stack of soil, waste

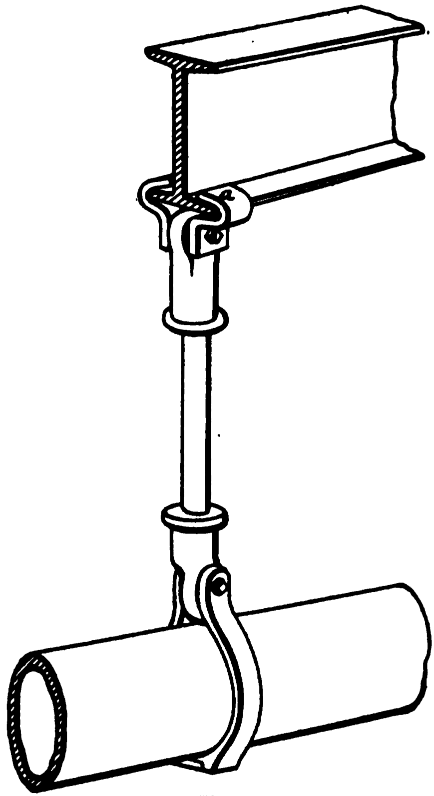

Fig. 78.

or vent or leader pipe. When possible the hangers are put near the hubs of the pipe in preference to

near the center of a length, as by so placing the hangers less stresses are brought on the joints to cause them to leak.

INSTALLING CROOKED SOIL PIPE.

In some localities most of the available cast iron soil pipe is more or less crooked, and, unless extra care is exercised in handling such pipe a poor job will be the result. If the pipes are installed with the crook, or bend, either at the top or bottom, the result will be a series of shallow pools for the retention of sewage, unless the drain has a very steep grade. The best practice is to so turn the pipes that all crooks will be at the sides. This will present a very wavy line of pipe to view, but the curves are of such large radius that they do not materially interfere with the flow of sewage within, so are more objectionable on account of their unsightly appearance than because of the resistance they offer to the flow of sewage.

LEVELING THE HOUSE DRAIN.

When installing the drainage system within a building, no part of the work perhaps requires greater care than that of leveling the house drain. To speak accurately, the house drain is not leveled, but on the contrary is given a certain uniform fall per foot from its extreme end to the outlet in the house sewer. This grading of the house drain, however, is usually spoken of, in the trade, as "lev-

eling" and the word will be so used here. To insure accurate results, the level to be used in the operation should be tested before using, to make sure that the instrument is not out of true. An ordinary spirit level is used for this purpose and it can be tested for accuracy by placing the level on some horizontal object, noting where the bubble stands in the level, and then reversing the level, to see if in the reversed position the bubble occupies the same relative position. If it does, the level is accurate. If it does not, the level is out of adjustment, and should be corrected before use. It is necessary in testing the level to have it occupy the exact position in the original and reverse tests, and to make sure, while the level is in its original position, its location is marked. Having ascertained that the level is accurate, the next consideration is to so use it as to get accurate results. If the level is applied direct to the top of a length of pipe, and the pipe happens to be a little crooked, dipping toward the center of the length, the level might indicate a slight fall to the drain, while as a matter of fact, the hubs of the pipes forming the drain are actually level. Further, if the level were applied to the lower end of the pipe, near the hub into which it is calked, the level would indicate that the drain had a fall in the wrong direction. Again if the spigot end of one length of pipe is not entered true in the hub to which it is calked,

the difference might cause inaccuracy in the result obtained by placing the level on that length of pipe. For these reasons it is always better, when leveling iron pipe, to use a straight edge, which is long enough to reach from the hub of one pipe to the hub of the next pipe. Even then, care must be exercised to get accurate results. Owing to the curvature of the hubs of the pipes, if the straight edge is not placed exactly on the center of the hubs, the readings of the level cannot be depended on as true. If the straight edge were placed on the center of the lower hub, but to one side of the center on the higher hub, the level might indicate a perfectly level drain, when as a matter of fact the drain has a good fall. Conversely if the straight edge is placed on the center of the up-grade hub, but to the side of the center on the down-grade hub, the level might indicate a good fall to the drain, while, as a matter of fact, the pipe is level.

Another source of error that often creeps into leveling operations when using a straight edge is due to the fact that the top edge of the board is not perfectly square with the sides. If the top edge of a straight edge has a slight bevel, and the level is not held exactly parallel with the straight edge, the level can be adjusted to give a reading of fall or no fall, level or not, as the manipulator of the level wishes. Often a number of fittings are so bunched together in a drain pipe that a straight

edge cannot be applied to the top of the drain at this point. So long, however, as the level will reach from hub to hub, it can be used without the intervention of a straight edge, and where the level will not reach from hub to hub, the straight edge can be applied to the fittings at the under side of the drain where there are no branches to interfere with the operation.

It is reasonable to suppose that there is a certain fall or grade for each size of house drain that is just right for that particular size of pipe and that any greater fall or grade would be too much for the best results, while a less fall would not be sufficient. Such in fact is the case. There are what is known as scouring velocities in a drain, depositing velocities, and the velocity best suited to the purpose. For instance, if the velocity of flow through a drain be too slow, the matter carried by suspension in the water will have time to settle out and deposit on the bottom of the pipe. If on the other hand, the velocity of flow is too fast, the liquid partition will run away from the more slowly moving solids, leaving them stranded high and dry on the sides or bottom of the pipe until another flush of water comes to move them a little nearer toward the outlet in the sewer. It has been found, both by experiment and in practice, that the inclination or fall to be given to drains, varies with the diameter of the pipe and is greatest for the pipe

of smallest diameter. The fall for a pipe should be sufficient to give the velocity of about 275 feet per minute or from about 4 to 5 feet per second. The proper fall for various sizes of pipe to give the sewage the required velocity, can be found in the following table, in which one foot of fall is allowed for the length of pipe given under the various diameters of pipe.

TABLE OF FALL OF DRAINS.

Diameter of Drain in Inches..	2	3	4	5	6	7	8	9	10
Length in feet to one foot of Fall	20	30	40	50	60	70	80	90	100

In addition to having a special grade or fall for each size of pipe, drains should have a uniform pitch or fall throughout their entire length, and the line of pipe must not have any part of it run level, or dip below or rise above the line of grade, as such deviations from the line of gradient will form shallow pools for the retention of sewage.

THE INSTALLATION OF RAIN LEADERS.

Connecting Rain Leaders to Cisterns.

GUTTERS are provided on the roofs of all buildings and rain leaders are connected to the gutters, to carry off the rain water falling on this surface, thus preventing the nuisance of rain water flowing about the premises or settling in yards, areas or cellars. In many localities the water from wells, streams and other sources is so impregnated with sulphur, salt, or others minerals, as to render it unfit for most domestic purposes. In other localities, the water is so hard, that while it can be used for most purposes, it is found very unsatisfactory for laundry work, and bathing. In such localities, as well as in many suburban places where there are no water works, cisterns are constructed and the water from the roof surface is collected and stored in these underground caverns. Sometimes, however, the cisterns are not built underground, but in their stead a storage tank is provided in the attic of the house and at such an elevation that water from the roof can discharge into the tank by gravity through the rain leaders.

The material for rain leaders discharging into cisterns or tanks is governed by an entirely differ-

ent set of conditions than when the rain water is to be discharged into the drainage system. Rain water collected in cisterns or tanks is stored for future use and both the receptacles and the leaders should be made of some material which will not affect the waters flowing through or stored in them and render them unfit for use. Iron pipes, particularly wrought iron and steel pipes, are quickly corroded by rain water and give off a red oxide of iron which when there is a sufficient amount of the water will discolor clothes when used for laundry work, and will stain kitchen ware and table ware. Lead is slightly dissolved by rain water from lead pipe or sheet lead and as lead is a cumulation poison which is injurious to the human system, it is not a suitable material for this purpose. Copper is the best above-ground material for rain leaders which conduct water for storage, although heavily tinned or well galvanized iron will prove equally suitable, while the protection coat lasts, but will not be found so serviceable. The best material for underground leaders connected to a cistern is salt-glazed earthenware pipe with the joints made of Portland cement.

Rain leaders connected to cisterns or tanks should be provided with a cut-off to allow water from the roof surface to run to waste during the first 5 or 10 minutes of a storm, the length of time depending on the intensity of the rainfall. This

is to allow the dirt to be washed from the roof and not be carried into the cistern or tank, where it would settle to the bottom and ferment or putrefy. The amount of dirt on a roof is much greater than is commonly supposed. Dust and horse droppings from the street are carried there hourly during dry weather; excrement of birds, fallen leaves, and moss add their substance to the impurities, and in

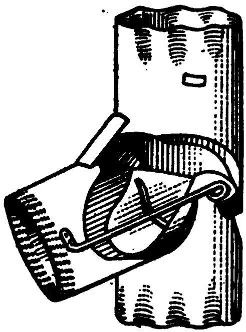

Fig. 79.

the vicinity of manufacturing cities, coal dust, ashes, and various products of incomplete combustion, are added to the other impurities, which are washed off during the first part of every storm.

A simple cut-off for a rain leader is shown in Fig. 79. The branch, through which water runs to waste may discharge on the pavement, or into a branch pipe connected to the house drain. This

latter method is the better practice, when the house is fitted with plumbing. The cut-off is provided with a movable gate, which in the position shown in the illustration, deflects the falling water into the side branch; when sufficient water has run to waste, to wash the roof, the gate is moved into the position shown by dotted lines and the rain water flows straight through the cut-off to the place of storage.

CONNECTING RAIN LEADERS TO SEWERS.

When rain leaders are not connected to cisterns or tanks, to save the water for domestic use, they should be connected to the house drain, to get rid of the unnecessary water, which otherwise becomes a nuisance, and to flush the house drain and house sewer, thus keeping them clean.

OUTSIDE LEADERS.

Rain leaders may be located either inside or outside of the building, and they are named according to their location, as inside leaders or outside leaders. In localities where the mean winter temperature seldom falls below 30° Fahrenheit, outside leaders may be used. Outside leaders are usually made of some sheet metal, usually tinned, or galvanized iron, put together with slip joints like the lengths of a stove pipe. This cheapens considerably the cost of the rain leaders and these will prove perfectly satisfactory in warm climates, al-

though they will not be as durable as pipes of heavier material more securely installed. In cold climates outside leaders are often used, even though they are liable to stoppage and injury from frost. The bursting of outside leaders from frost can be avoided to a great extent by making them of corrugated sheet metal instead of plain sheet metal. When a plain sheet metal leader, fills with water and freezes there is no provision for expansion and the result is the leader opens at the seam or the sheet metal itself bursts. The result, of course, is a leaky downspout which must be repaired. When a corrugated pipe fills with water and freezes, on the other hand, the corrugations yield to the pressure and the pipe remains intact, although slightly bulged at that point. Of course, repeated freezings would ultimately burst a corrugated pipe, but repeated freezings are at such long intervals, that danger from that source is reduced to the minimum if not entirely obviated. Outside leaders should be provided at the top with a service box, set low enough so water from the roof can flow into it, and at the same time overflow without backing up on the roof in case the service box or leader is stopped with leaves or other rubbish, or filled with ice.

Cast iron pipe with calked joints is not a suitable material for outside leaders. Owing to its being a good conductor of heat, and there being consid-

erable thickness to the walls of the pipe, water would freeze flowing through it, much quicker than it would in a sheet metal pipe. Furthermore, the method of joining lengths of cast iron pipe together is not suitable for this purpose. The oakum used for packing the joints becomes saturated with the water flowing through and upon subsequently freezing forces the lead out of the hubs. If cast iron must be run for rain leaders in exposed places, the joints should be made with rust, smooth-on, or stick-to iron cement, without the use of oakum; or lead wool can be used to calk the joints, without using oakum for packing.

When outside leaders are placed on a building in an exposed position like an alley, courtyard or other place where they are liable to damage, from vehicles, for a distance of about five feet above grade, they should be made of cast iron, run in a niche in the wall, or protected with wheel guards. Up to the point where the iron pipe ends, the work is usually done by the plumber, while all sheet metal work is generally done by the sheet metal worker.

INSIDE LEADERS.

Inside leaders are installed by the plumber. They are made of cast iron, wrought iron or steel pipe, put together perfectly gas and water tight, and are located within the building secure from frost or other injurious agency. As they are located

within the building they must conform to all the requirements for the drainage system, both from sanitary and structural standpoints. If they were not air tight, drain air would escape into the building, vitiating the air, while if they were not water tight, the rain water might do untold damage to building, furniture and furnishings. The connection of a rain leader to the house drain should be made with a full Y fitting, so the water will flow freely in the direction of the house sewer outlet. If T fittings or TY fittings were used, during a heavy downpour, the water from the rain leaders would cut off the flow of sewage from that portion of the house drain back of where they discharged into the drain. It would seem almost unnecessary to say that a rain leader should never be used as a soil or waste pipe nor a soil or water pipe used for a rain leader. The severe pull of the water flowing through rain leaders would be liable to siphon the water from all the closet traps discharging into the leader, to say nothing of the agitation of water in the bowls of closets, caused bv the rain water, even if it did not destroy the seal. Further, should a stoppage occur between the leader and the drain, all the water from the roof would discharge through the lower closet outlets.

Leader pipes should never be connected to the roof or gutter by means of a rigid connection; a

short section of sufficiently pliable material should be used to allow for any variation in the length of the leader stack. Usually a short length of 8 pound lead pipe, or 18 ounce seamless drawn copper tubing, is used for this purpose. This section of pipe is securely soldered to the gutter, and made tight to the iron leader stack by means of a solder nipple, or brass ferrule, screwed or calked, according to whether the pipe is cast iron or wrought pipe. The solder nipple or ferrule, as the case may be, is joined to the lead or copper pipe by means of a solder wiped joint. The entrance to the leader pipe should be made slightly funnel shaped, to permit the entrance of water with the least loss of head; and the inlet should be protected from the entrance of leaves, and other substances carried onto the roof, by means of a brass grating or wire basket, secured in place.

TRAPPING RAIN LEADERS.

Most cities having plumbing ordinances, state in the code the manner in which all rain leaders shall be trapped. Where there is no code, however, the leaders should be trapped with a running trap containing a cleanout opening, and placed in the horizontal run, just inside of the cellar wall, where it will be accessible for cleaning and at the same time secure from frost. In the absence of rules to the contrary, traps may be omitted from leaders which

are perfectly gas and water tight and which open a sufficient distance away from doors, windows, ventilation flues, chimneys, or other openings to a building, so as not to create a nuisance. From 12 to 15 feet should be a sufficient distance for this purpose. By leaving the leaders untrapped a better circulation of air through the drainage system is assured, and the pipe serves the dual purpose of rain leader and vent stack.

SIZE OF RAIN LEADERS.

Rain leaders must be proportioned to carry off the greatest quantity of water that will be discharged into them during periods of excessive precipitation. They should never be smaller than 2 inches in diameter, and for large roofs, should be of sufficient size to care for all the water falling on the projected roof area. A simple empirical rule for determining the size of rain leader necessary is—allow one square inch in sectional area of the leader for every 250 square feet of projected roof surface. A leader proportioned by this rule will give large enough pipe for any conditions or locality.

YARD AND AREA DRAINS.

Area ways, paved courts, the floor of light shafts, and driveways, are usually provided with a drain pipe, connected to the house drain through which to carry off all the rain water and melted snow so

it will not create a nuisance around the premises. The entrance to a yard or area drain is provided with a slotted or perforated cover or grating large enough to admit the maximum amount of water it will have to accommodate, and with small enough openings to prevent the entrance of anything which would be liable to stop the drain. Under ordinary

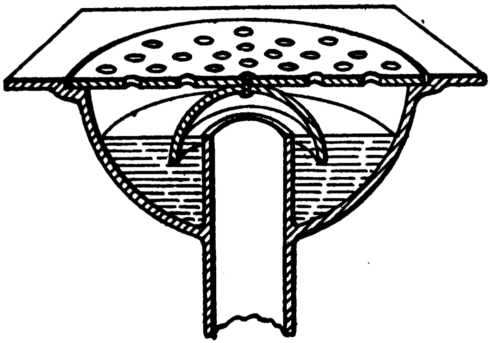

Fig. 80.

conditions, light cast iron covers or basins may be used, but when the drain is located in a paved court or alley, the drain should have a heavy frame and cover to withstand the wear and impact of heavy truck wheels. Areas and yards that are not paved, do not require to be drained, the water being allowed to settle into the earth and flow off with the ground water. When courts and yards are paved or cemented, the inlet to the drain should

be located at the lowest point, and the pavement or cement concrete made to slope toward that point. Very little grade is necessary for this purpose, and

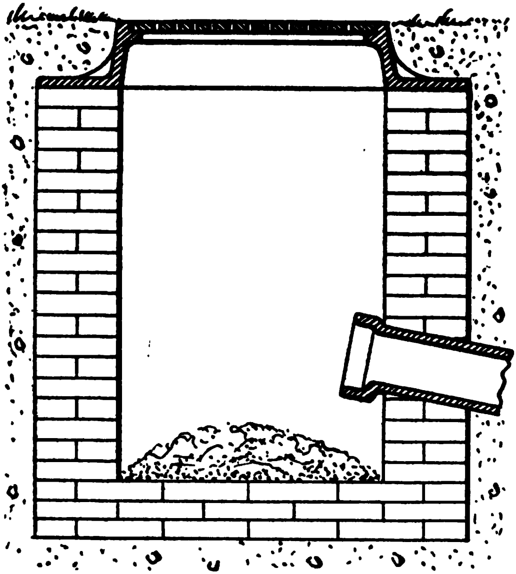

Fig. 81.

when the surface is fairly level, a grade of 1-inch in ten feet will be found sufficient.

In many localities bell traps have been used as inlets to yard and area drains. They are wholly unfit for this purpose, however, and should not be

used. A bell trap is shown in Fig. 80; the cover to this form of trap is easily removable and consequently taken off by children, who then amuse themselves filling the drain pipe with sticks and stones. Servants remove the cover to brush in sweepings from the yard or area; accident displaces the cover which becomes lost or broken and in any of the foregoing cases the seal is broken by the removal of the cover and air from the drainage system then escapes from the open mouth of the pipe. Furthermore, in warm dry weather, the water is quickly evaporated from the trap on account of the large surface of water exposed, and the heat pouring down on the iron top. In cold weather, the water freezes in the trap which is then liable to be so damaged that it will not effect a seal when the ice has thawed. At all events, should a sudden thaw come the trap would still be choked with ice and the drain would prove inoperative. This type of trap, once extensively used, has now fallen into disfavor, and should not be used for any purpose in a drainage system.

A type of catch basin extensively used in connection with yard and area drains, is shown in Fig. 81. This is made of brick walls, 8 inches thick, and plastered on the inside with Portland cement to make it watertight. Instead of being made of brick, the basin may be made of cement concrete, or cast iron basins may be used. The waste pipe

from this type of catch basin passes through the side of the basin, and a sufficient distance, usually 12 inches, above the bottom, to form a receptacle for any dirt or sand washed or otherwise carried into the basin. During wet weather the basin fills to the level of the waste pipe before any water overflows into the drain. This water, however, forms no seal, nor does it play any other useful part, so that its presence or absence is immaterial in warm climates. In cold localities, however, the water in

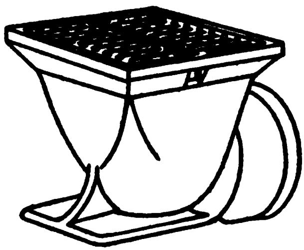

Fig. 82.

the bottom of the basin is liable to freeze and upon expanding damage the walls to such an extent that it will not hold water. To avoid that possibility the bottom of this type of catch basin is sometimes made spherical so that the water in freezing can expand without doing any damage.

A cheap, simple and effective yard or area catch basin is shown in Fig. 82. This is simply a plain cast iron receptacle, with large perforated re-

movable cover, and so constructed that all water and dirt carried in suspension will pass right through and be carried to the house drain by succeeding flushes of water. This seems to be the best type of catch basin for either warm or cold climates. It contains no water to freeze or affect a seal. There is no space for the accumulation of rubbish. It requires no cleaning, for anything carried into the basin can easily be swept through to the sewer, and it is practically indestructible.

SIZE OF YARD AND AREA DRAINS.

Yard and area drains are seldom made smaller than 3 inches in diameter and only in extreme cases are larger drains required. Indeed, when the drains have a good fall, it is doubtful if 2-inch pipe will not prove sufficiently large for most purposes, and 2½-inch pipe large enough for average use. When large areas of paved surface is to be drained, however, much larger pipes will be required, and their sizes will be best proportioned by calculating them according to the rule for finding the size of rain leaders, for to a great extent, yard and area drains partake of the nature of rain leaders. The perforated cover to yard and area catch basins must bear some relation to the size of the drain pipe. If there is insufficient area of openings in the cover, sufficient water cannot flow into the catch basin to flush the drain. Ordinarily it is as-

sumed that the area of perforations in the cover should be equal to twice the area of the drain pipe.

TRAPPING YARD AND AREA DRAINS.

It is customary to trap yard and area drains with a running trap located just inside the foundation wall, where it will be safe from frost and freely accessible for cleaning. Yard and area drain-traps are provided with cleanout hubs, into which is calked a cleanout plug. When convenient to do so, it is good practice to combine the drains from two or more areas or yards, and run them into one trap; or when there is a trapped leader convenient to a yard or area drain, the drain may be connected to the leader pipe back of the leader trap. By so doing the drain trap may be omitted and the leader trap made to serve for both.

FLOOR DRAINS.

In many establishments, such as breweries, laundries, canning plants, bottling works and like places, more or less water is spilled on the floor, or allowed to run to waste and follow the grade of the concrete to a sewer outlet. In such places, floor drains are provided to carry off the water, and the entrance to the floor drain may be protected by a metal strainer, placed over a catch basin such as is shown in either Fig. 81 or Fig. 82. When, however, there is danger of fibrous materials or any other substance, entering the drain that would be

liable to cause stoppage, a catch basin with a pocket below the waste outlet should be provided, or a floor drainer, such as shown in Fig. 83, may be used. In case there is danger of water backing up through the floor drain during stoppage of the sewer, on account of the slight distance it is above the main drain, a back water trap should be used in connection with the catch basin. Such a trap is shown in connection with the catch-basin in Fig. 83. The

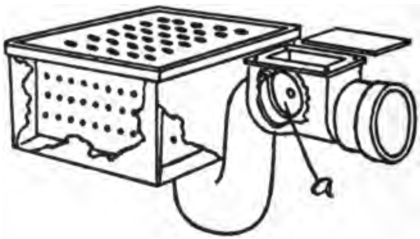

Fig. 88.

flap "a" opens readily to pressure from the inlet end of the trap, but closes instantly against a back pressure, thus interposing a barrier against the flow of sewage onto the floor.

CELLAR DRAINS.

Cellars which are built in damp places where the floor is always wet, or where running water from a spring or seepage from the soil accumulates in the low places, can be fitted with a floor drain, or catch basin to receive the water and a pipe to

connect it with the house drain. It is better, of course, to make the cellar impervious to water, but that is a structural detail and if neglected by those having the matter in charge, or if, on account of the expense or any other reason, the walls and floor are not made waterproof, then the method already mentioned may be used, provided, the cellar bottom is above the level of the main drain

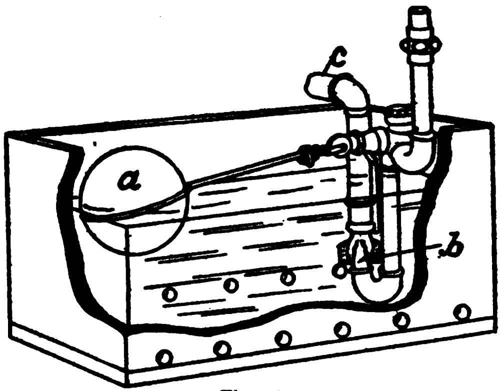

Fig. 84.

pipe, and there is sufficient seepage to maintain a seal in the trap during the entire year. When, however, the cellar floor is above the level of the sewer or when the flow of water into the cellar is intermittent, some other means must be employed to discharge the water into the house drain. The water can be collected in a sump and pumped out

periodically, or an automatic cellar drainer, Fig. 84, may be installed, so that as soon as the water rises in the sump to a certain level, the cellar drainer will be brought into action immediately and eject the water from the cellar.

This apparatus may be operated with steam, compressed air, or water, but is commonly operated by water from the city water mains. The apparatus is operated much on the principle of an injector. It is placed in a box or tank, having perforations for the water to enter, in a pit below the level of the cellar floor, and to the side of the building from which the surface water comes. Every arrangement is then made to facilitate the flow of water into this pit. When the water reaches a certain level, it raises the float "a," this turns city water onto the apparatus and as the water flows through the injector nozzle "b," it entrains water from the pit which mixes with the city water and together they are discharged into a water supplied sink or some other convenient receptacle, through the pipe "c." When the water is emptied from the pit, the float falls, thus shutting off the flow of city water until the pit fills again. Discharging water from a cellar by means of a cellar drainer is too expensive a method to use for discharging large quantities of water, and the apparatus are not economically effective for a greater lift than 12 feet, although they can raise water a much

greater distance. The height to which water can be raised by this means, depends upon the available water pressure. With a pressure of 100 pounds per square inch, water can be raised 25 feet, but the amount of city water required to raise water that height, makes the method too expensive for handling large quantities of water.

SEWER AND TIDE WATER TRAPS.

House sewers which discharge into tide waters or into lakes or streams which are subject to floods,

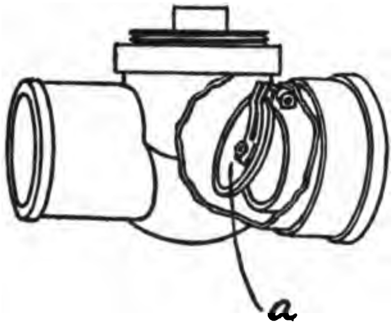

Fig. 85.

consequently have different water levels at different times, should have a vent pipe connected to the sewer above the high water level, to prevent tide water, or high water from air-locking the sewer. Further, such a sewer should be provided with a tide water trap, to prevent the water backing up in the sewer, when there are fixtures connected to

the system at so low an elevation that the water might overflow them. A tide water trap is shown in Fig. 85. This consists simply of a check valve or flap "a" which opens to the pressure of the sewage from the house side of the trap and closes against the passage of sewage or water when the pressure is from the outlet end of the trap. When the house sewer is a long one, the practice is to

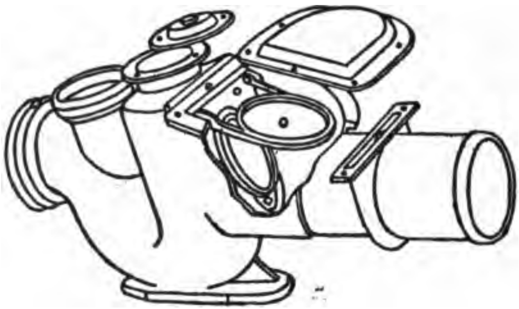

Fig. 86.

place the tide water-trap near the outlet, and when the house sewer is short, to place the tide-water trap inside of the foundation wall, on the outlet end of the main drain trap. When used in this location a combination tide-water and main drain trap, such as is shown in Fig. 86, is frequently used. This fitting, when properly operating prevents the passage of either air or water from the outlet toward the inlet end of the drainage system.

A tide-water trap cannot be depended on under all conditions to maintain a perfectly tight water seal. Should a wad of cotton waste, piece of stick or any other bulky substance become caught in the

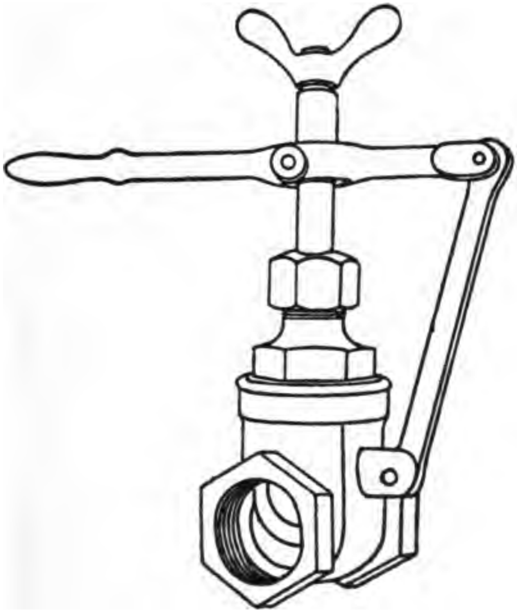

Fig. 87.

check by the descending flap, a perfect seal would not be effected, and during flood periods water would pour freely through the trap and overflow the basement fixtures. To guard against this pos-

sibility, a quick closing lever handle gate valve, such as shown in Fig. 87, is generally placed in the house drain, on the outlet side of the tide-water trap. Many buildings on the banks of rivers periodically have their cellars flooded, during high stages of the river, by backing up through the drainage systems in which no provision was made to guard against such a contingency.

In some cities built on sloping or hilly sites, the main sewers in some of the lower streets are so small that during heavy rain storms the storm water overflows the manholes in the streets. Naturally, when the water rises so high in the street sewers, it would overflow basement and cellar plumbing fixtures unless provision were made to prevent the damage. In buildings where there are no basement or cellar fixtures, and the drain is in perfect condition, so it cannot leak, a tide water trap and quick closing gate valve may be omitted, and the water permitted to rise in the drain and stacks, during the brief period of the storm. When, however, basement fixtures are installed in the building, the main drain should be divided into two main branches. One, discharging direct into the main drain trap, may be used for all the fixtures above the level of the street, which can then be used during rainstorms, while the other branch should take in all the fixtures below high water level in the street sewers and this branch should

be provided with the tide-water trap and quick-closing gate valve. By this arrangement of the drainage system, all fixtures on the upper stories of the building may be used during flood periods, for any head of water in the soil or waste stacks would displace an equal amount of water from the house drain and force it into the street sewer.

BOILER BLOW-OFF CONNECTIONS.

Most cities having plumbing codes require that the blow-off pipe from boiler be connected to the house sewer on the street side of the main drain trap, and that the blow-off water from high-pressure boilers pass through a cooling tank before being discharged into the sewer. Where there is no plumbing code the same conditions should be observed and a Y fitting should be provided in the house sewer, close to the foundation wall for the blow-off pipe to connect to. It will be observed that it is not required to pass through a cooling tank, the blow-off water from an ordinary low pressure boiler, such as is used for house heating. The reason for this is that the amount of water so blown off is never very large, and its temperature not much over 212° Fahrenheit, consequently it is quite safe to allow this water to run direct into the drainage system outside of the main-drain trap. The house sewer at this point is buried in the moist earth which is such a good conductor of heat that water from

a low-pressure boiler will become comparatively cold, almost immediately after reaching the sewer, and very little steam will arise from it. Should any steam be liberated, it will be cut off from the building by the main-drain trap, and no damage can ensue.

The reason that blow-off water from a high pressure boiler is required first to be cooled, then to be discharged into the house sewer on the street side in the main-drain trap, is that the water is so hot that if discharged direct into the system on the house side of the trap, great damage would result. There would be no objection if the water were cooled to ordinary temperature, but instead of being at ordinary temperature the water is overheated and corresponds to the pressure of steam within the boiler. In high-pressure systems the temperature of the water is sometimes as high as 350 degrees Fahrenheit, and when this water is released from pressure, part of it immediately flashes into steam and expands in all directions. If the blow-off pipe from a boiler is connected to a drainage system, as soon as the water flashes into steam, the steam expands and fills all the pipes, which it heats to about 200° Fahrenheit. The pipes, which before this were at ordinary temperature of say 76° Fahrenheit, are immediately expanded and elongated by the heat and as the stacks move lengthwise, they strain branches, raise fixtures, and if the drainage

system is of cast iron pipe with lead calked joints, the expansion and working of the lines might affect all the joints, working them loose so they will not be gas or water tight or sufficiently rigid to hold the lengths in place. Besides this, the working of the stacks is liable to chip or crack the plaster and otherwise offset the building structure.

The blow-off tank and connections to the steam boiler are made by the steam fitter and all that is required of the plumber is to provide a suitable opening in the house drain and extend it to the inside of the cellar wall where it will be convenient for connection. A 3-inch opening will generally prove of sufficient size for this purpose and extra wrought pipe or cast iron pipe may be used for the purpose. When wrought pipe is used, it should be well protected with a coating of zinc or with a covering of asphaltum. Usually, it will prove a point of economy to both galvanize and dip in asphaltum the pipe to be so used, as it will materially prolong its life. When cast iron pipe is used, the joints should be put together with a rust preparation or with the commercial preparation, smooth-on or stick-to iron cement.

THE COMPLETE HOUSE DRAIN.

A complete house drain from the street sewer to the rising stacks of soil and vent pipe, is shown in Fig. 88. The house sewer connects the street

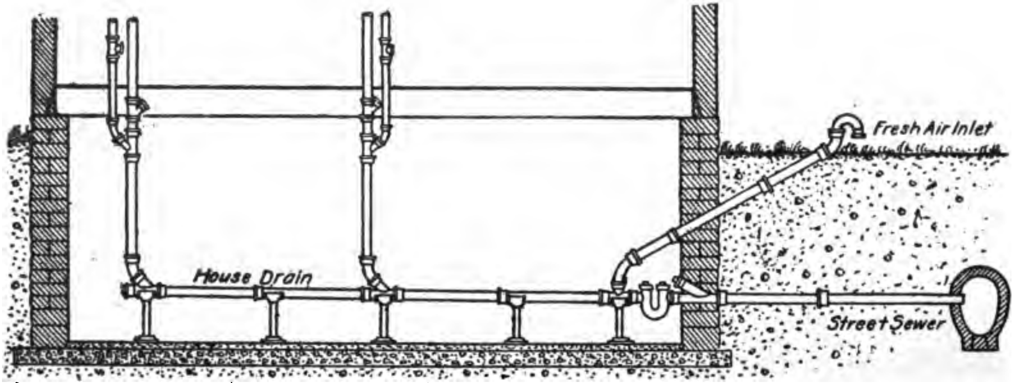

Fig. 88.

sewer with the house drain. Inside the foundation wall, first there is a Y fitting with a cleanout plug in the branch, next comes the main-drain trap with two cleanout plugs calked in the top opening. Just inside the main-drain trap is a T fitting to which the fresh air inlet is connected. This inlet extends to outside of the building where it terminates in a return-bend facing the ground. The rising stacks of soil pipe are taken from the horizontal drain by means of Y fittings, which are turned to an upright direction by means of 1/8 bends. In the end of the house drain is calked a cleanout ferrule through which a rod can be inserted and push any obstruction clear to the main-drain trap. On the street side of the main-drain trap a rod can be pushed through the cleanout opening in the branch to the Y and extended clear to the house sewer. It will thus be noted that the interior of the house drain and house sewer are accessible throughout their entire lengths.

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